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Edited by H. H. Brown, A. M. Inst. N. A.

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New Great Lakes Steamship South American

Description of a Single-Screw Passenger Steamer Now Under Construction at the Great Lakes Engineering Works for 1914 Delivery

The Great Lakes Engineering Works, Detroit, Mich., now has under construction for the Chicago, Duluth & Georgian Bay Transit Company a steel screw steamship which will be named the *South American*. The steamer will have a capacity of 540 passengers and a crew of 161 and will be used exclusively in the passenger trade between Chicago, the Georgian Bay ports and Duluth.

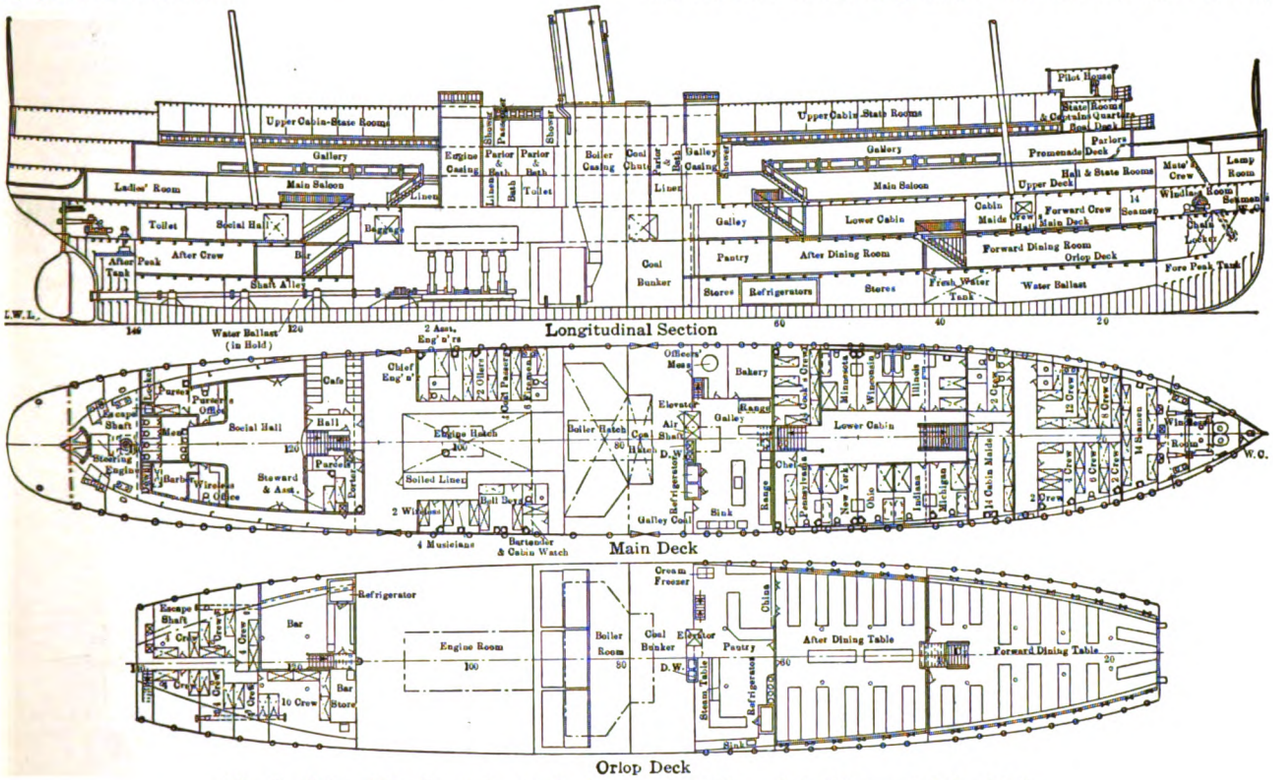

Fig. 1.—Inboard Profile of the *South American* and Plans of the Main and Orlop Decks

The principal dimensions are:

Length over all	314	feet.
Length on keel	291	feet.
Breadth, molded	47	feet.
Depth, molded	18	feet.
Service speed	17	miles per hour.
Maximum service speed	18	" " "

The vessel has five complete decks, the lower three being of steel. Six watertight bulkheads divide the ship into seven watertight compartments.

General Arrangement

Forward on the lower or orlop deck is the main dining room with accommodations for 276 passengers, and the pantry. The dining room is finished in silvered oak with cork tile floor. Below the dining room and pantry are located large storerooms, refrigerators and fresh-water tanks. Aft on this deck are the bar and crew's quarters. The bar is located directly under the social hall and is finished in fumed oak with tiled floor. There is a built-in refrigerator and a large storeroom.

On the next deck above, which is the main deck, space in the stern is given over to the social hall and the passengers' entrance. These rooms are finished in birch and leading from the social hall are the purser's room, barber shop, café and parcel check room. Forward of the social hall are the baggage room and accommodation for the engineer's crew.

Amidships on the main deck, directly over the pantry, is the galley, which is connected by elevator and dumbwaiters to the pantry and storerooms below. Just forward of the galley is the lower saloon, opening out of which are nine par-

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lor staterooms, each with private bath and fitted with double brass beds and mahogany furniture. Stairs lead from this saloon directly to the dining room below.

At the extreme forward end of the main deck is the windlass room with a No. 8 steam spur gear windless. The chain locker is below in the forepeak, while between the windlass room and the lower saloon are quarters for the dining room and cabin crew.

The main saloon is on the upper deck, and is reached from the social hall below by the main stairway. The main saloon to a gallery which overlooks the main saloon. Access to the gallery is provided by broad stairways forward and aft of the engine and stack casings. At the head of both stairways are hallways on either side opening on to the deck.

A covered promenade 9 feet wide and furnished with deck and steamer chairs extends entirely around the ship. At the extreme after end, inclosed by wire guards, is a children's open-air play-ground supplied with swings, hammocks and various out-door games. A large box of pure white sand is also provided for the amusement of the smaller children.

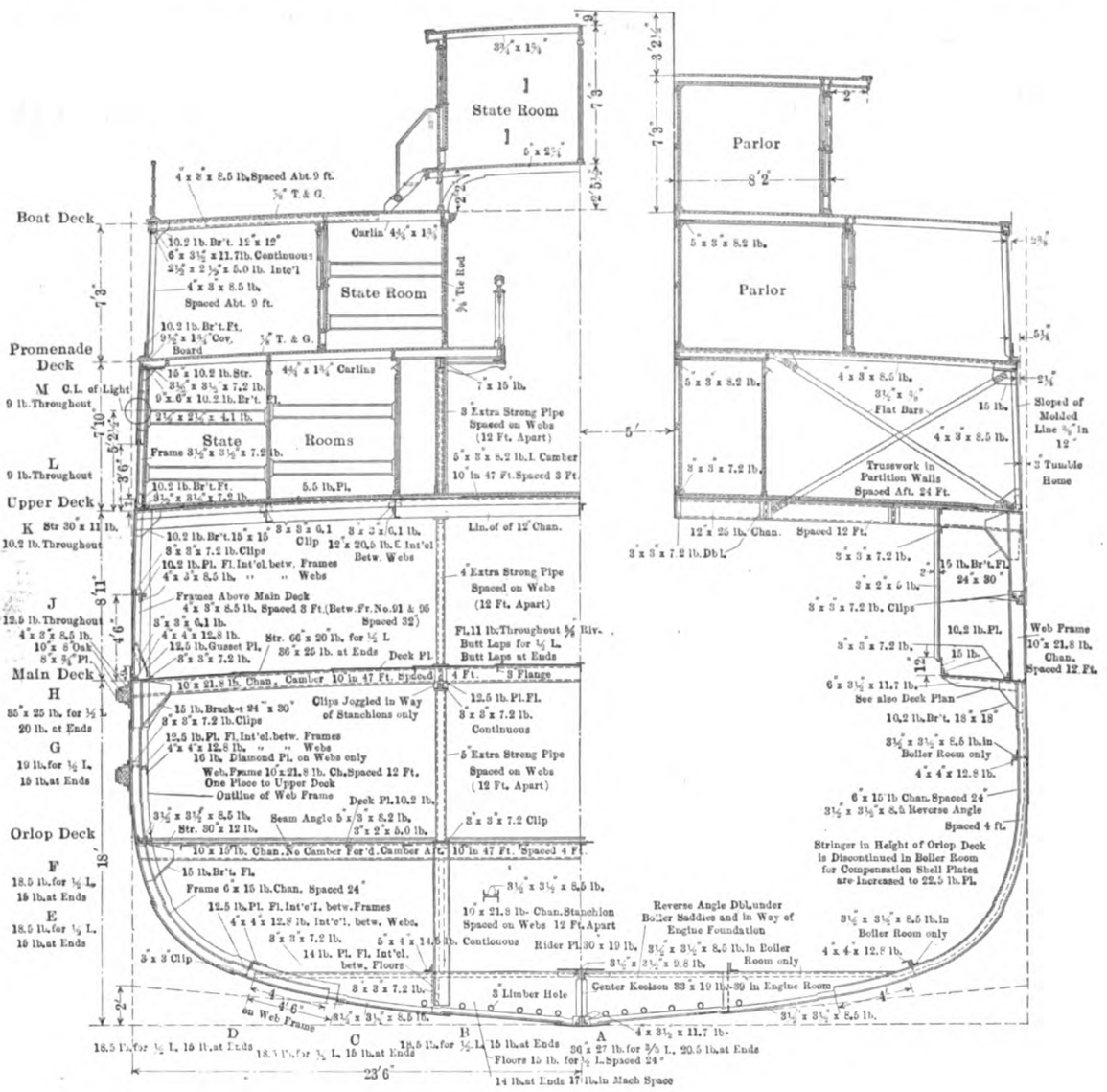
State Room
Parlor
Boat Deck
Promenade Deck
Upper Deck
Main Deck
Orlop Deck
State Rooms
Trusswork in Partition Walls Spaced Aft. 24 Ft.
Sloped of Molded Line ⅝" in 12"
3 Tumble Home
Web Frame 10" x 21.8 lb. Chan. Spaced 12 Ft.
Stringer in Height of Orlop Deck is Discontinued in Boiler Room for Compensation Shell Plates are Increased to 22.5 lb. Pl.
Reverse Angle Dbl. under Boiler Saddles and in Way of Engine Foundation
Center Keelson 33 x 19 lb.-39 lb. in Engine Room
Floors 15 lb. for ½ L. Spaced 24"
23'6"

Fig. 2.—Midship Section

is finished in cream enamel, and leading off from it are 128 staterooms with accommodations for 256 passengers. Separated from the main saloon by a glass partition and French doors at the after end, is a ladies' cabin finished in silvered oak. Both the main saloon and the ladies' cabin are furnished throughout with comfortable leather chairs and settees. Quarters for the petty officers are also located on the upper deck, but they are forward of the main saloon and separated entirely from it.

The deck above the upper deck, which is known as the promenade deck, is given over entirely to staterooms and a covered promenade. In addition to 52 staterooms with 104 berths, on this deck, there are also 14 parlor staterooms with baths accommodating 28 passengers. The staterooms open on

On the boat deck are 57 staterooms and 8 parlors with bath, giving a total capacity of 134. At the forward end of the boat deck and directly under the pilot house are quarters for the captain, consisting of an office and stateroom. At the extreme after end of the boat deck is a glass inclosed ball room and observation room, provided with a maple dancing floor.

The ship has running water in all staterooms and both hot and cold water in all parlors.

Lighting is by electricity, the current being supplied by two 50-kilowatt turbine generators. In the main saloon, the lighting is on the indirect principle. Mechanical refrigeration is supplied to all cooling rooms by a 12-ton refrigerating plant. All water used for domestic purposes is filtered.

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Every possible appliance to insure safety in operation is provided, including the Schutte recording compass and Nicholson log. Lifeboats and rafts of sufficient capacity to accommodate the entire complement of passengers and crew are provided, while a wireless equipment with a radius of 250 miles is installed.

Propelling Machinery

The main engine of the *South American* is a vertical quadruple expansion engine, having cylinders 21½ inches, 30¾ inches, 44½ inches, and 64 inches diameter, with a common stroke 36 inches. The estimated indicated horsepower at 115 revolutions is 2,550, while the maximum indicated horsepower will probably reach 2,850 with an increase in the number of revolutions to an estimated maximum of 125. The usual arrangement of the cylinders has been followed and the sequence from forward to aft is high pressure, low pressure, second intermediate and first intermediate pressure. The crank sequence is high pressure, first intermediate, low pressure, second intermediate.

A great deal of attention has been given to the proper balance of the moving parts of this engine, inasmuch as the length of her run will not permit of any perceptible vibration throughout the ship, which, while always objectionable in any ship, would seriously interfere with the earning capacity of this vessel in particular.

The high-pressure and first intermediate cylinders have one piston valve each, the diameter and travel being 12 inches and 5½ inches for the high-pressure and 17 inches and 6 inches for the first intermediate. The second intermediate cylinder has two piston valves, each 14 inches in diameter and 6 inches travel and the low-pressure cylinder has a double-ported slide valve with a travel of 6½ inches. All valves are driven with Stephenson link motion, the low-pressure having a balance cylinder.

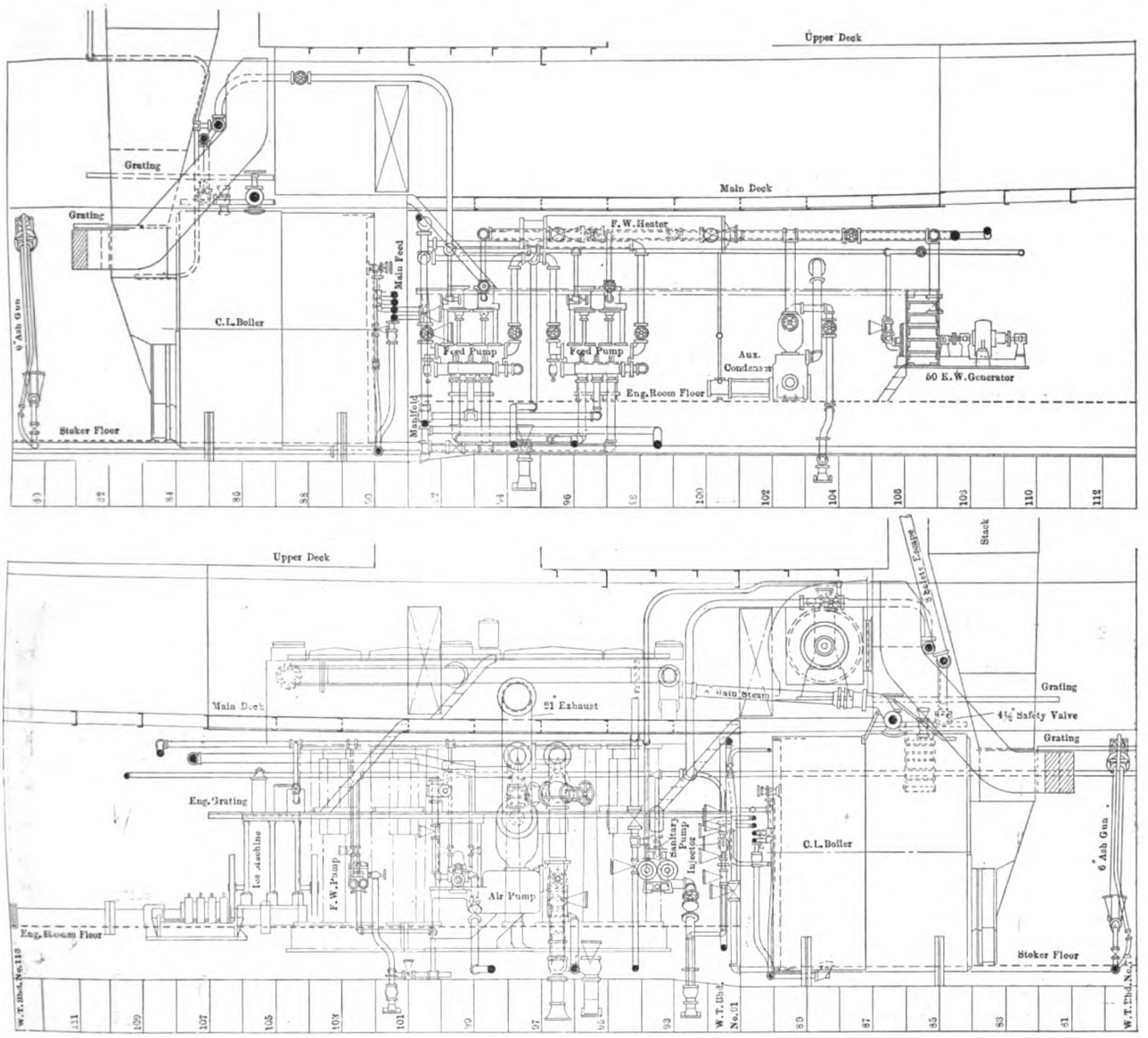

Fig. 3.—Port and Starboard Views of Machinery Space, Showing Piping Arrangement

The high-pressure piston is a plug piston of cast iron, fitted with anti-friction rings. The first intermediate piston is of cast steel fitted with a solid removable follower of iron and the second intermediate piston is similarly arranged, with the exception that the piston body is of iron and purposely weighted to assist in the balance. The low-pressure piston is of cast steel with packing rings and removable follower plate. All pistons are conical in section and the low-pressure and first intermediate are made as light as possible.

The piston rods of open hearth steel are 5⅛ inches in diameter in the body, secured to the pistons with a 3¾-inch nut and to the crossheads with a taper key. The crossheads are

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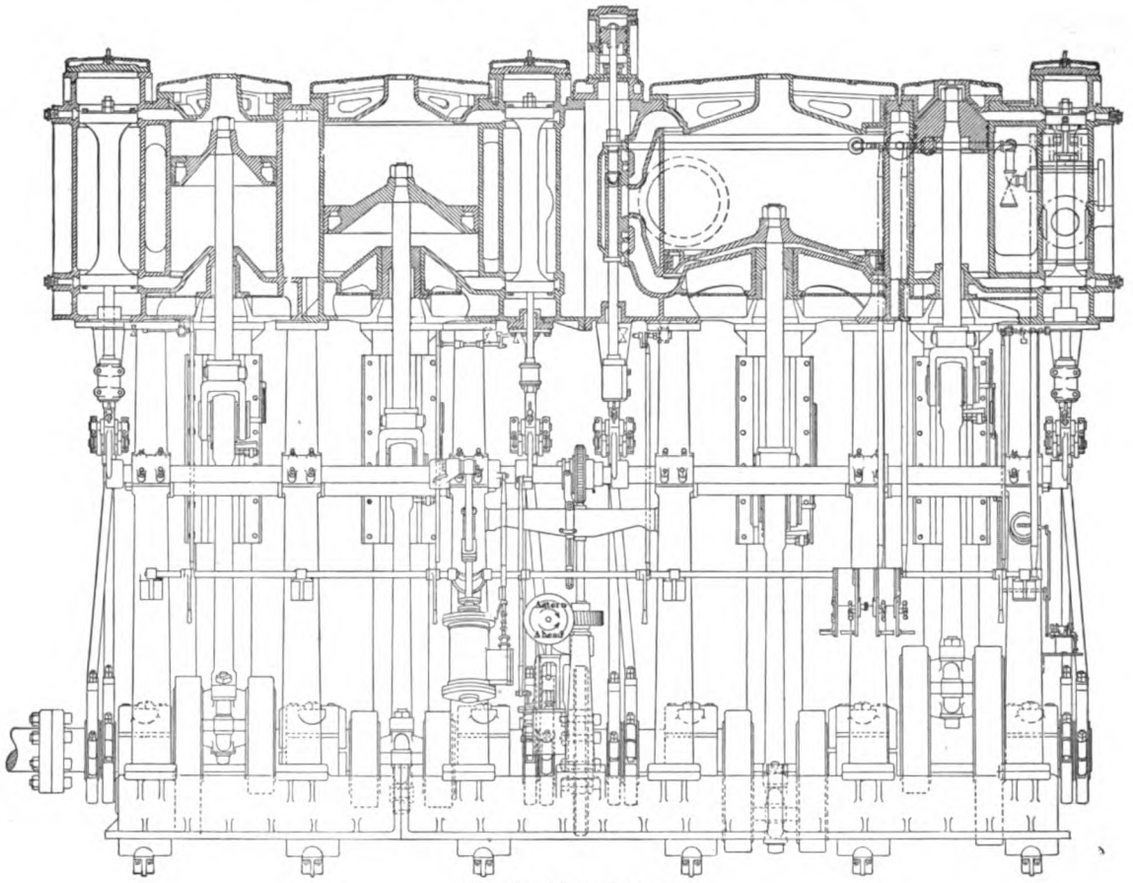

Fig. 4.—Main Engine

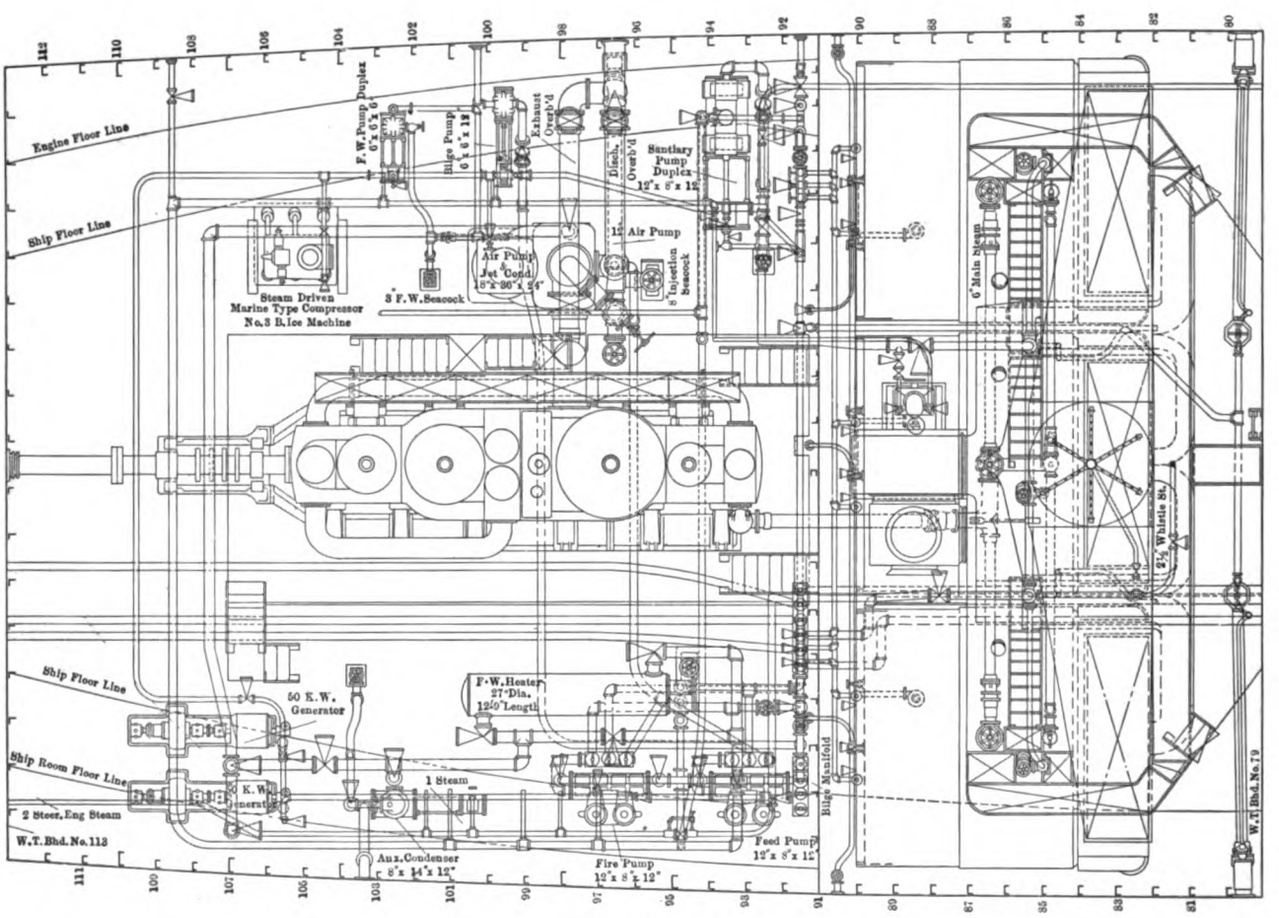

Fig. 5.—Plan of Machinery Space

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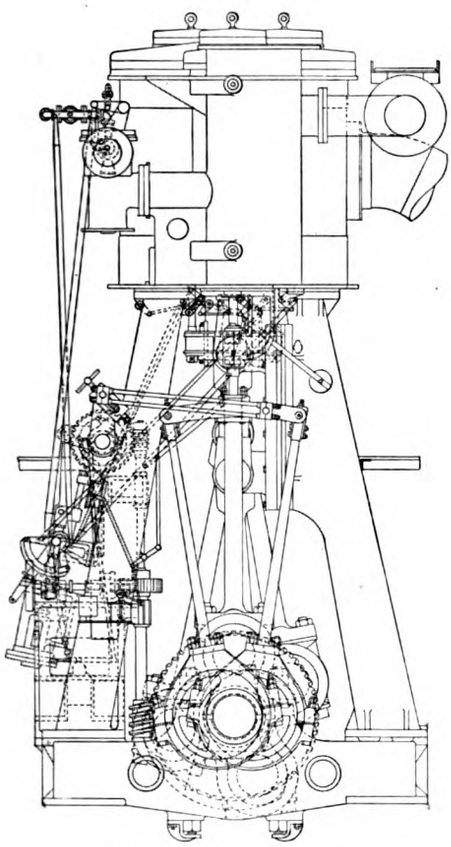

Fig 6.—End View of Main Engine

of cast steel fitted with removable brass shoes for both ahead and backing slides, while the crosshead pins are of machine steel taper fitted to the crossheads and are 6 inches in diameter by 8½ inches long.

The connecting rods are of open hearth steel 7 feet 3 inches long center to center, with brass top end boxes, adjustable for wear with a taper wedge. The crank pin boxes are of cast steel lined with babbitt and secured to the tee-ended connecting rod with annealed steel bolts, 2¾ inches diameter and a 3-inch thread. The connecting rod body is 4¾ inches in diameter at the top and 5¾ inches at the bottom.

The crank shaft is of open hearth steel of the built-up type with cast steel slabs securely shrunk and pinned to the shaft. The diameter of the crank shaft and crank pins is 12½ inches and the length of the crank pins 12½ innches. The shaft is supported in six journals, two of which are 19½ inches long and four 15 inches long, all lined with babbitt and having semi-steel caps secured with steel binder bolts, 3¼ inches in diameter.

The thrust bearing is of cast iron with cast iron shoes faced with babbitt and fitted for water circulation; the thrust pressure being taken up on four collars with a unit pressure per square inch of about 60 pounds.

The thrust shaft is of open hearth steel 12 inches diameter with coupling and thrust collars forged on. The line shaft is also of open hearth steel 12 inches diameter, supported in babbitt-lined, steady bearings placed at intervals not exceeding 18 feet. The tail shaft is 12½ inches in diameter in the body and 13½ inches in the stern bearing, which is 5 feet 7 inches long.

The propeller is of the sectional four-bladed type 12 feet 9 inches diameter, with a uniform pitch of 14 feet 9 inches and a developed total blade surface of 62 square feet. The hub and blades are of special mixture of tough cast iron with machine steel studs and brass nuts.

The bedplate and both front and guide columns of the engine are of cast iron box sections, all properly and securely bolted at their various points of connection. Reversing of the engine is accomplished with a direct-acting steam cylinder 10 inches bore and 15 inches stroke, and a double auxiliary reverse and turnover engine is provided, having cylinders 4½ inches bore and 6 inches stroke. This engine is so arranged that it automatically stops when the valve gear of

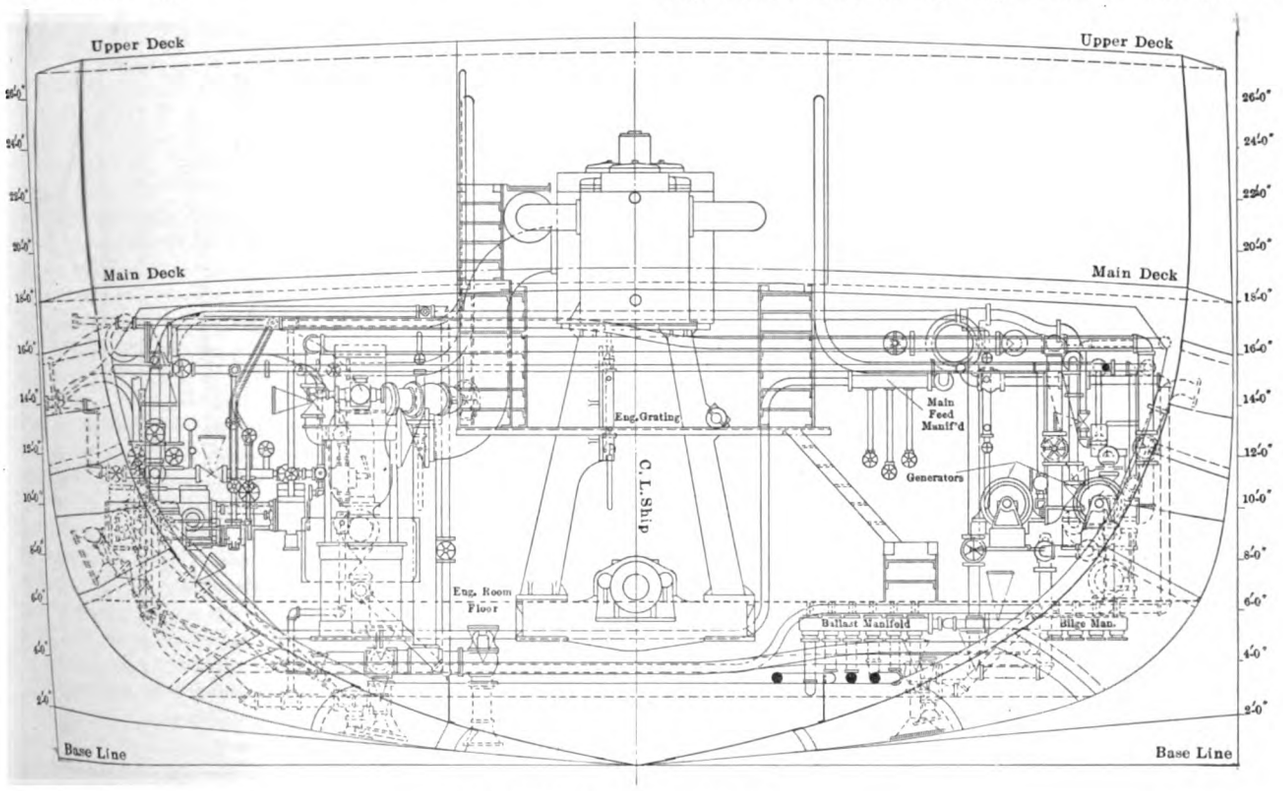

Fig. 7.—Section Through Engine Room

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the main engine has reached either full ahead or astern positions.

Main Boilers

The main boilers are three in number, each 14 feet mean diameter and 12 feet long overall, built for a working pressure of 215 pounds per square inch. Each boiler has 3 corrugated furnaces, 42 inches inside diameter, and separate combustion chambers. The total heating surface of the three boilers is 7,293 square feet, and the total grate surface 157½ square feet, making a ratio of heating surface to grate area of 46.3 to 1. The boilers work under a system of positive heated draft, the air being led to the furnaces through a system of ducts and not upon the closed stokehold system.

The individual main steam stop valves on each boiler are 6 inches diameter and the steam pipe to the engine throttle 8 inches diameter. The auxiliary stop valves are 3 inches in diameter, safety valves 4½ inches, the feed valves 2 inches, the main blow-off 2½ inches, and the surface blow-off 1½ inches, in diameter, respectively.

Engine Room Auxiliary Machinery

All the pumps in this ship are independent of the main engine. The main air pump is a vertical double-acting pump of the simplex type, having a steam cylinder 18 inches in diameter and 24 inches stroke, and the air cylinder 36 inches diameter and 24 inches stroke. Feed pumps in duplicate are fitted, each pump being 12 inches by 8 inches by 12 inches of the duplex type. One sanitary and fire pump, duplex 12 inches by 8 inches by 12 inches, one bilge pump, simplex, 6 inches by 8 inches by 12 inches, one fresh-water pump, duplex, 5 inches by 6 inches by 6 inches, one auxiliary condenser and simplex air pump 10 inches by 14 inches by 12 inches, complete the list of pumps fitted; each being properly piped to perform its individual duty, the main air pump being connected to the engine room bilges, also, for use in emergency.

The engine for driving the forced fan is a vertical single engine, 6 inches bore and 6 inches stroke.

Current for all electrical requirements is furnished by two 50-kilowatt turbine-driven generators.

The refrigerating machine is of the vertical type, with one steam cylinder and one compressor of 12 tons per 24 hours, refrigerating capacity.

A feed water heater and internal type feed water purifiers are fitted, all in accordance with the latest practice for this class of apparatus.

Russian Merchant Marine.—According to Government statistics, the Russian merchant marine consists of 1,016 steamers of 487,000 tons; 52 motor vessels of 13,000 tons, and 2,577 sailing vessels of 257,000 tons. The fleets of the Black, Azof and Caspian Seas represent 40.7 percent of the total number and 47.4 percent of the total capacity. During 1912 and 1913 the largest Russian steamship companies made extensive purchases of new steamers, of which 75.7 percent were built in English yards. About two-thirds of Russia's foreign trade is carried over seas, but only about 12 percent is under the Russian flag. The slow growth of the Russian fleet is attributed in part by the *Daily Consular and Trade Reports* to the comparatively small returns from the industry and to the crowded condition of the dockyards with government orders. Of Russian sailing vessels, however, only about 3 percent are built abroad.

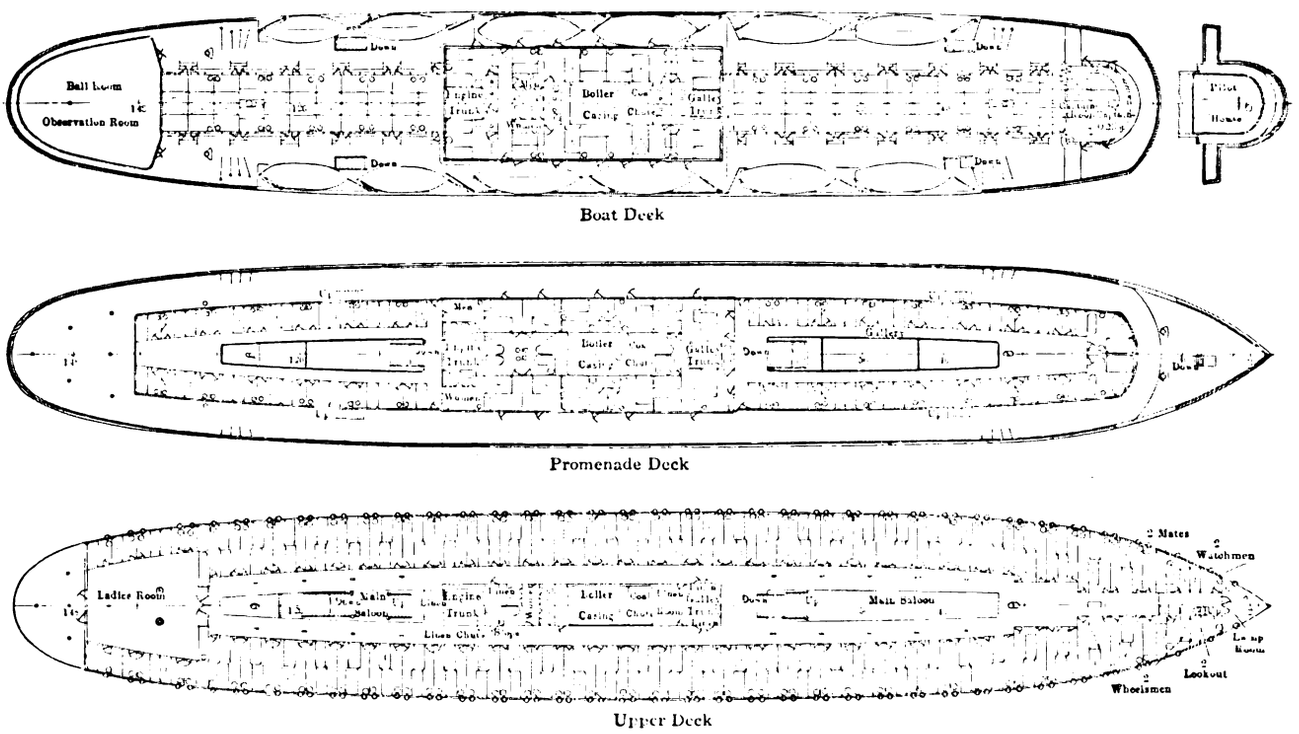

Fig. 8.—Deck Plans

The American Floating Exposition.—A floating exposition that will introduce the products of American manufacturers to the merchants of the West Indies and South America, with the object of increasing trade with those countries, is being arranged by the American Trade Tour Company, 15 Maiden Lane, New York. The steamship *Kroonland*, an American-built ship flying the American flag, has been chartered for the exposition and will leave New York on October 14 for a tour that will extend over 120 days, visiting the most important ports on the east coast of South America. There will be accommodations on the steamer for 400 traveling salesmen, and space enough for the display of the manufactured products of several hundred concerns. At Buenos Ayres time will be allowed for the salesmen to visit Chili and points on the west coast.

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Care of the Electric Plant on Board Ship

Faults in the Armatures of Dynamos —How to Find and Remedy Them

BY SIDNEY F. WALKER

A fault is the term used by electrical men to describe a source of trouble; something that either stops the apparatus working or causes it to work badly. The armatures of all dynamos, whether used as generators or motors, are the seat of frequent troubles. Probably faults in armatures are more prevalent than faults in all of the other parts of the apparatus put together. It is the armature that is doing the work, that is subject to all the strains—both electrical and mechanical—that is subject to wide changes of temperature, and so on.

The principal faults found in dynamo armatures are:

(1) A break in the circuit of the armature.

(2) A connection between two adjacent coils, or between two adjacent wires of the armature.

(3) A connection between one or more of the coils upon the armature and the core.

Fault No. 1 is perhaps the most serious fault of all, because it stops the working of the machine. With faults Nos. 2 and 3 the machine may go on working for a certain time and may even be made to continue working under special conditions, providing that it is understood the convenience will have to be paid for later on.

A break or a disconnection in the armature may arise in the middle of one of the coils, though it is very rarely that such a thing happens. When such a fault does occur it is a very troublesome one, because it is so very difficult to find and because the coil has to be taken right off for repair. The only case in which, in the writer's experience, such a fault has occurred has been where either inferior wire has been employed, where there has been a weld in some part of the coil, or where a joint has been made in the wire with which the coil is wound. Modern dynamo makers are very careful indeed as to the quality of the wire which they employ, and as to the firms whose wire they use; but with the very best firms and with the greatest amount of care it may sometimes happen that there is a weld in the wire, somewhere in the length of an armature coil. In the process of wire drawing welds are necessary. Experienced wire drawers make then as few as possible; but it may happen that a wire breaks in going through one of the draw plates, and rather than sacrifice the whole coil a weld is made, as carefully as possible, and after the wire has been covered with two coatings of cotton, the cotton being varnished or protected by one of the insulating materials upon the market, or even when the wire has been enameled, according to the latest method of insulating wires for electric magnets, it is practically impossible for the man who winds the coils to know of the existence of the weld. If the weld is properly made, probably it is as good as the wire itself. It will introduce a very small resistance into the circuit, and its presence might be suspected, by very careful tests, from this cause.

On the other hand, welding tends to make the wire brittle just by the side of the weld, and it may happen later on, when that particular portion of the coil is exposed to a considerable amount of heat, possibly followed by contraction, and again followed by heating up, that the wire may break just beyond the weld. It may also happen that by accident, or through shortage of wire in the works, together with pressure for delivery, two pieces of wire are jointed together to form a coil. This, of course, should not be done; but under pressure things of the kind often are done, particularly when repairs to machines are executed. The jointing process has the same tendency to render the wire brittle just beyond, and the same thing may happen.

But by far the most common cases of disconnection occur at the commutator; particularly after repairs have been executed. It will be remembered that the adjacent ends of two armature coils are connected together, and to a segment of the commutator. Sometimes there are arms standing up from the commutator, sometimes the wires are embedded in slots in the segments. With either method it requires considerable care and skill to make sure that the joint is a good one. The slot in which the wires are to be held should be carefully cleaned, all grease thoroughly removed, the slot itself thoroughly tinned, the ends of the wires thoroughly tinned and the whole bedded together with solder.

Another possible cause of disconnection is that the ends of the coils may be broken off between the armature and the commutator. This is due to various causes that have not been thoroughly investigated.

Both a connection between two adjacent coils or between two adjacent wires of the same coil, and a connection between any coil and the iron core, will lead to heating of the armature and to sparking. It may be taken as an axiom that when sparking increases the condition of the armature should be suspected. It may be due to the causes mentioned in the article dealing with sparking; but if, after applying the remedies mentioned there, sparking still continues, the armature should be carefully examined for heat. When the two wires, forming the ends of a coil, are connected together, that coil will heat up, and it will usually heat so badly that there is no question as to where the trouble is. When a coil is in connection with the iron core the heating will be less; but it will usually declare itself by heating up that particular coil to a certain extent and by increased sparking when that particular coil passes under the brush.

The cause of two wires forming the ends of a coil being connected together is very frequently at the commutator. If the commutator has been trued up, it may happen that very minute pieces of copper are left connecting two adjacent segments together. It has also frequently happened that when a commutator has been taken off to repair the armature and has been replaced, the two ends of one coil have been connected to the same segment of the commutator instead of the two ends of adjacent coils, as it should be.

The cause of a coil becoming connected to the core is usually a fault brought about during construction. The armature core is built up of a number of thin iron or mild steel plates, from which pieces have been punched out, the gaps so made together forming the channels in which the wires are laid when the armature is wound. Unless great care is taken it may easily happen that very small pin points of iron or steel are left sticking up, and with the increase of temperature to which the machine is subject when it is running and the vibration to which the armature is also subject, these pin points may work their way through the insulation and make connection with the inner coil.

One connection between a coil and a core will not do a great deal of harm; it will merely give rise to heat, and possibly the machine may have to run a little faster; but two such connections may cause the machine to refuse to furnish its full pressure, unless driven at a very much higher speed than the normal; and it will lead to the development of a very large amount of heat in the coils between the two connections.

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How to Find the Faults

A good deal may be done toward finding all the faults by carefully observing the sparking at the commutator. With a break in the armature circuit no pressure will be furnished, but there will be a small spark when the disconnection comes round to the negative brush in the case of the generator and the positive brush in the case of the motor. It is not always easy to locate the position of the spark, and therefore some kind of test has to be applied. The surest method is to make another break in the armature by disconnecting two ends of adjacent coils from their segment of the commutator and carefully separating them. Then by testing round with a small battery and either a galvanometer or a small cell-testing voltmeter, the break will be easily located. Having formed

Motor Cattle Schooner Vaquero

a testing circuit of the battery and the galvanometer or voltmeter, one end of the circuit is connected to one of the wires that have been disconnected from the commutator, and the other wire is touched on each segment of the commutator in succession. The galvanometer or the voltmeter will give a deflection at each segment until the break is passed. The break, however, may be found without disconnecting, by the aid of a telephone and a battery.

When the position of the disconnection is found—if it does not appear to be at the commutator itself, as mentioned above—that coil will have to be taken off, and it will probably be found that there is a break inside. The coil which is short circuited, between which connection has been made either by a piece of copper between the commutator segments or the equivalent, needs no testing. It shows by the heat in the coil itself; and the writer would like to give the practical hint that, after an armature has been repaired, if the commutator has been disconnected—even if only a portion of it has been—the armature should be run slowly, without any load, and the coils very carefully examined for heat. The heating will take place when the armature is run very slowly and without any connection to the outer circuit.

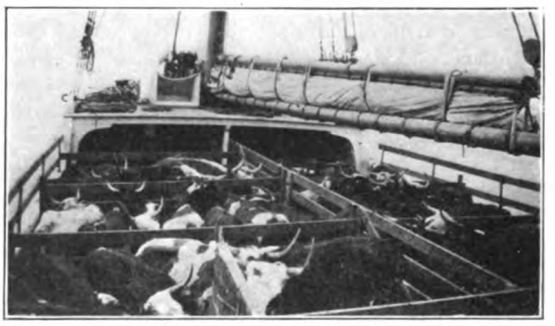
A connection between one of the coils and the core is also easily found by the aid of a battery and either a galvanometer or a testing voltmeter. A testing circuit is formed with the battery, the galvanometer or voltmeter and the two end wires. One of the end wires should be connected to the armature shaft, the brushes having been thrown back, and the other end wire touched on one of the commutator segments. If there is a connection between any of the coils and the core a deflection will be shown upon the galvanometer or voltmeter; and by passing the testing wire round the commutator, or what amounts to the same thing, by holding the wire in one position and moving the armature slowly round, the position of the coil connection will be found by the fact that, with a galvanometer, the deflection will be reversed.

Motor Cattle Schooner Vaquero

One of the largest of this year's motor work boats on the Pacific Coast recently completed a successful trial trip at San Pedro, Cal., and is now in commission on the run between the Santa Rosa Islands and San Pedro. The name of the vessel, *Vaquero,* meaning "Cowboy," is quite appropriate, in view of the fact that she is primarily intended to be used as a cattle carrier on the run between San Pedro, Santa Barbara, and the Santa Rosa Islands, although she is well able to handle freight if desired.

This vessel was built by William Muller at the Banning Shipyards, San Pedro, Cal., for Messrs. Vail & Vickers, of Los Angeles. In general design she resembles the familiar class of steam schooners of the Pacific Coast, but in detail she shows a marked simplicity of finish, which, while extremely plain, is very effective and entirely different from that which has ordinarily been adopted by vessels built in the past. The *Vaquero* is 130 feet overall, with 29 feet extreme breadth and a draft of 10 feet. On the main deck and in the forward hold there is provided space enough to carry ten carloads of grown steers; in other words, about 250 head; or, instead, she can carry 1,200 head of grown sheep. She is completely fitted with staterooms for the officers, and has comfortable crew's quarters forward. Storage for two 18-foot boats is arranged for on the upper deck.

The main engine is a 250 horsepower four-cylinder Union, of the open crosshead type. Located on the main deck, in the forward end of the engine hatch, is the electric lighting and pumping set, which consists of an 8 horsepower double cylinder Union special electric engine, direct connected to a 4 kilowatt Crocker-Wheeler generator on one side, and a 4-inch by 4-inch Deane triplex fire and bilge pump on the other. A friction clutch is provided, which allows the pump to be thrown in and out of action at will. Overhead exhausts with mufflers will be used for the main and auxiliary engines; the mufflers being placed in a stack gives her the appearance of a steam



Deck Load of Cattle on the Vaquero

schooner, and at the same time provides efficient ventilation for the engine room.

On the forecastle deck there is a Providence pump brake windlass, connected with a chain drive to a 16 horsepower, double cylinder Union hoisting engine, the messenger chain sprocket on the drum shaft being provided with a clutch so that it shall be disengaged when the hoist is being used for handling cargo.

Two fuel tanks with a total capacity of 4,200 gallons are located in the engine room. There are also two water tanks, each having a capacity of 950 gallons. One of these tanks is intended for ship's use, and the other to provide water used in the vaporizer of the main engine.

Messrs. Vail & Vickers are the owners of the power schooner *Santa Rosa Island,* which has been in commission for ten years. She has not sufficient capacity for present and future requirements, however, and the *Vaquero* has taken her place. The unqualified success of the *Santa Rosa Island* is,

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doubtless, responsible for the installation of distillate engines in the larger vessel. In addition to the run of more than 100 miles into the open sea from San Pedro to the Santa Rosa Islands, the *Vaquero* will carry cattle and freight up and down the Meixcan coast.

Reconstruction of the Carolina

The steamship *Carolina,* of the New York & Porto Rico Steamship Line, arrived in the port of New York from Newport News, Va., on the afternoon of March 2, in many respects a new ship, having been reconstructed by the Newport News Shipbuilding & Dry Dock Company during the past nine and a half months, from plans and specifications prepared by Theodore E. Ferris, naval architect and marine engineer, of New York City, in collaboration with Mr. Franklin D. Mooney, vice-president and general manager, New York & Porto Rico Steamship Company. The reconstruction work was carried on under the supervision of Mr. Ferris.

It will be recalled that the *Carolina* was originally the *Grand Duchess,* built for the Plant Line as a twin-screw freight and passenger ship, and later owned by the Savannah Line and named *City of Savannah.* Following this she became the property of the New York & Porto Rico Steamship Company, and was named the *Carolina.*

Previous to her reconstruction she was operated on the Porto Rico line for a number of years, but was not wholly successful, as many repairs were necessary on almost every voyage to keep the vessel operating. Not only were the boilers deficient and worn out, but the propulsive efficiency of the vessel had always been deficient and inadequate, because of an abnormal bossing out condition about the stern in the original construction of the ship for the twin-screw arrangement. The time having come for reboilering the ship, renewing the tank top in the boiler space, and other miscellaneous work necessary, it was decided, after several conferences of the board of directors, headed by Mr. Mooney, at the recommendation of Mr. Ferris, to rebuild the ship, not only to make her efficient in regard to speed and economy of power, but in return increase her earning powers as regards increased deadweight cargo capacity and cubic capacity, reduction in crew and increased passenger accommodations.

After a thorough survey of the hull of the ship was made, the condition of the hull was found to be excellent, as there was practically no deterioration. Plans and specifications were prepared and a contract was placed with the Newport News Shipbuilding & Dry Dock Company for the reconstruction of the ship, changing her from a twin-screw to a single-screw vessel, and installing new boilers, new engines and auxiliaries. The work represented what is probably the most intricate and largest rebuilding proposition on any ship done in this country, reflecting great credit on the part of the owners in undertaking such a proposition, which has resulted in now making this vessel a complete commercial success.

The *Carolina* before being altered to a single-screw ship was equipped with twin-screw quadruple-expansion engines, developing, collectively, about 7,000 indicated horsepower, two 16-foot diameter double-ended boilers and two 16-foot diameter single-ended boilers, fitted with forced draft. Her speed on the Porto Rico route was nominally 13½ knots; but the vibration, steering and handling qualities of the ship were not good.

The altered single-screw arrangement consists of one triple-expansion engine, with cylinders 31 inches by 50 inches by 34 inches, and a common stroke of 54 inches, and four single-ended boilers 16 feet in diameter, developing 4,000 indicated horsepower, which will give her a speed of 14½ knots on the Porto Rico route. On her sea trial on the trip from New port News to New York, with 1,100 tons of water ballast and coal, the ship developed on a four-hour run a speed of 16¼ knots; there was little or no vibration; the ship steered and handled perfectly, and showed exceptional seagoing qualities in the snowstorm and gale off the Atlantic coast on the night of March 1, a storm which delayed a number of incoming transatlantic vessels.

In the process of reconstructing this ship there has been gained, including the actual weight due to the reduction in the weight of the propelling machinery, reduction in bunkers and boiler feed-water, about 1,000 tons in deadweight, 35 percent in cargo cubic capacity, and quite an increase in passenger accommodations, the number of staterooms, suite rooms, private baths, etc., a reduction in the engine department crew and a vast reduction in coal consumption, all principally because of the ship's original abnormal condition at the stern around the propeller wheels. This is due to the change to a single screw, which makes her propulsive efficiency high and the necessary horsepower to obtain the desired speed vastly less than was originally required for the ship. The *Carolina* is of the following dimensions:

Length over all	405 feet
Length between perpendiculars	379 feet
Depth to hurricane deck	36 feet 7 inches
Beam, molded	47 feet 8 inches
Total deadweight at maximum load draft, including cargo, coal, water and stores	5,100 tons
Cargo, cubic capacity	260,000 cubic feet
First class passengers	190
Second class passengers	50
Crew, about	100

There are a number of suite rooms and private baths and public spaces about the ship, such as a smoking room, social hall, observatory, deck shelter, ladies' parlor, etc., which are elaborately finished. The dining saloon is a spacious and luxurious room, with the modern arrangement of small tables. The catering will be of the popular hotel service. Additional shade decks and awnings have been fitted, and the ship is equipped with boats with capacity for every person on board.

The *Carolina* has complete new propelling machinery of the very best construction, a thoroughly stanch hull with complete double bottom, numerous watertight bulkheads and other safety devices, all combining to guarantee the *Carolina* a high position among steam craft. The ship is commanded by Capt. J. O. Foss, commodore of the Porto Rico line. Mr. Stewart Holmes, who for several months has been at Newport News with the ship, acting as inspecting engineer, will be chief engineer of the vessel.

MONTHLY SHIPBUILDING RETURNS.—The Bureau of Navigation reports 68 sail and steam and unrigged vessels of 15,116 gross tons, built in the United States, and officially numbered during the month of February. Two of these were steel steamships, aggregating 8,834 gross tons, both of which were built on the Atlantic coast, the largest being the tank steamer *John D. Archbold,* of 8,374 gross tons, built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for the Standard Oil Company, of New Jersey.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS.—At a meeting of the Exhibition Committee of the National Association of Engine and Boat Manufacturers, Incorporated, held in New York, March 20, the following officers were elected for the ensuing year: President, John J. Amory, of the Gas Engine & Power Co., and Chas. L. Seabury & Co., Cons.; first vice-president, Henry R. Sutphin, of the Elco Company; second vice-president, W. H. Mullins, of the W. H. Mullins Company; third vice-president, Charles A. Criqui, of the Sterling Engine Company; treasurer, James Craig, of the Craig Engine & Machine Works.

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British-Built Destroyers for the Greek Navy

Description of Four Powerful Destroyers Built Originally for the Argentine Government But Subseqently Acquired by the Royal Hellenic Navy

BY F. C. COLEMAN

The outbreak of war in the Balkans in the autumn of 1912 found both sides lamentably unprepared as far as their naval resources were concerned. Bulgaria's available force amounted to perhaps ten small steamers of no real value and three 100-ton torpedo boats built in 1907. Servia, of course, has no navy, while the Greek Government possessed one fairly modern armored cruiser, the *Giorgios Averoff*, of 10,000 tons, built at Leghorn, and three ancient ironclads. These were supplemented by eight destroyers, built in 1906, four of the *Sphendoni* class, built by Yarrow, and four of the *Doxa* class, built by the Vulcan Company, which were originally fairly fast vessels of about 360 tons. Turkey possessed two ancient ironclads purchased from Germany, and two still more ancient vessels that had undergone reconstruction about eight years ago. Besides these she had two fast cruisers, the *Hamidieh* and *Mejidieh*, of 3,500 tons, built at Armstrong's and Cramp's, and two torpedo cruisers of 750 tons, built at Kiel. The Turkish torpedo flotilla consisted of four powerful 620-ton destroyers, purchased three years before from Germany, four 280-ton boats built in 1908, and eight or ten older boats. So far the balance of naval power, as far as ships went, seemed to lie with Turkey.

The decision of the Balkan League to attack Turkey was made in ample time for either Bulgaria or Greece to have acquired more ships, but such a purchase was eventually left till almost too late, although the question had been under discussion many months before. In July, 1912, however, with the object of strengthening its destroyer flotilla, the Greek Government purchased the then nearly completed destroyers *V* 5 and *V* 6, which were under construction at the Vulcan Company's works at Stettin for the German Government. These vessels now appear in the Greek navy as the *Neagenea* and *Keraunos*. They are of 700 tons displacement and about 32.5 knots speed. Slight alterations to the vessels' armament were made to suit their purchasers, the gun armament being increased to four 23-pounders in place of the German two. These vessels arrived in Greece in September, 1912, and saw a considerable amount of war service for several months.

In addition to these two ships the Greek Government, which had, early in the year, commenced pourparlers with the object of purchasing the destroyers building by Cammell, Laird & Company, Ltd., for the Argentine Government, eventually decided definitely to acquire them. These four vessels formed part of a programme of twelve destroyers ordered in pairs early in 1910 from two German and two French firms and from Cammell, Laird & Company, Ltd., of Birkenhead, who were entrusted with four boats, and at whose request the Argentine Government consented to annul its contract with them.

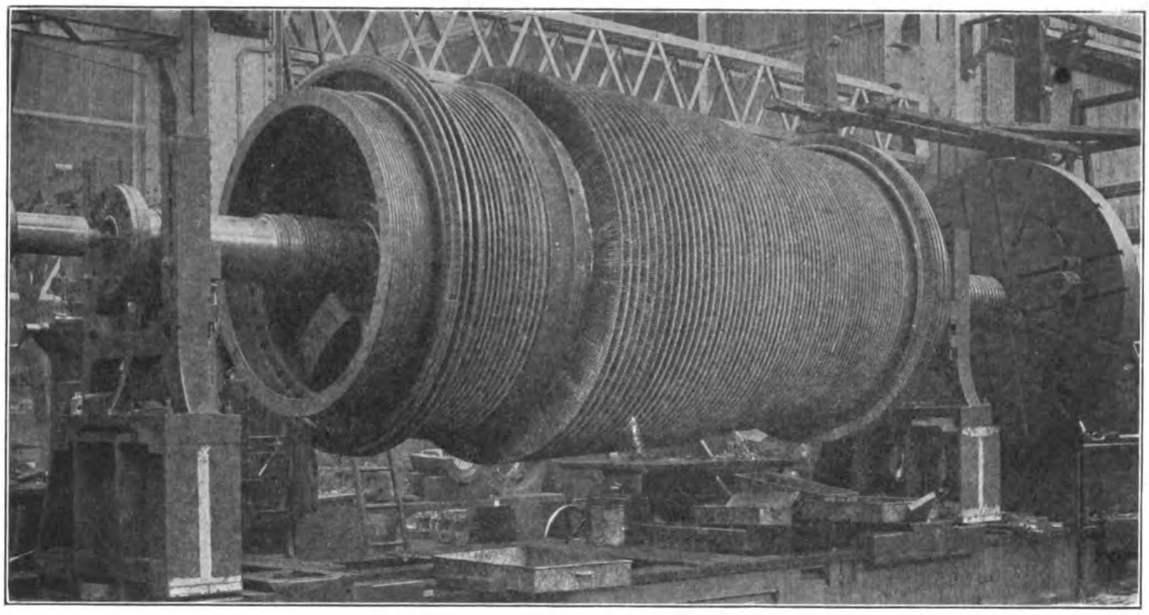

Fig. 1.—Turbine Rotor in Lathe, Showing Blading

The four ships, now known as the *Lion, Eagle, Hawk* and *Panther*, are large and powerful vessels of somewhat special design. Their length on the waterline is 285 feet, beam 27 feet 8 inches, and draft of water about 9 feet, the propellers, however, projecting considerably below this. At this draft their displacement is about 1,050 tons. The designed speed of 32 knots was slightly exceeded on trial. They are in consequence somewhat between the ocean-going destroyers of five years ago and the latest British Admiralty vessels.

A radical difference, however, lies in the arrangement of the machinery, the armament and the general equipment, all of which embodied features seldom met with in this class of ship. The propelling machinery consists of two separate and independent steam turbines in two compartments separated by a transverse bulkhead. The combined power developed on trial was about 22,000 shaft horsepower, the turbines running at 620 revolutions.

The design of the turbines embodies a high-pressure impulse wheel mounted at the forward end of the drum,

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whereon are also mounted about sixty rows of the ordinary Parsons blading. The turbine cylinders are of cast iron.

Steam is supplied by five boilers of the White Forster type, the pressure being 230 pounds. The total heating surface is about 27,000 square feet. Each boiler is in a separate compartment. Fore and aft bulkheads run the complete length of the engine and boiler rooms, forming side bunkers along the skin of the ship, and transverse coal bunkers are fitted opposite boilers 1 to 4.

No. 4 boiler is oil-fired and has a heating surface of 8,500 square feet. The total coal bunker capacity is 230 tons, with about 90 tons of oil, which is carried mostly in two main tanks at the ends of the vessel.

The arrangement of bulkheads and coal bunkers adds enormously to the safety of the ship in the event of damage, and greatly assists in the protection of the boilers in action. While this renders the hull construction of these destroyers excellent from the point of view of safety, the multiplicity of compartments does not facilitate supervision. Two fan engines are fitted in each stokehold, and each boiler has one main and one auxiliary Weir feed pump.

Two oil fuel pumps, delivering oil through a boiler of large dimensions, supply the oil boiler. Each boiler is fitted with separate feed heater. The remainder of the auxiliary machinery is of a comprehensive character.

In each engine room "Uniflux" condensers and a Weir "Dual" air pump maintain a vacuum of 28 inches when the vessel is running at full power. The two evaporators have a combined output of 40 tons per day. A 50-ton fire and bilge pump is placed in each engine room. The steering engine is placed in the after engine room. Bilge ejectors of high capacity are fitted throughout in each main compartment. The engine room ventilation is secured by means of electric fans.

The steam dynamos are situated in a spearate compartment aft of the main engines. The latter are of the A. E. G. turbine type, and supply all the power for ship lighting and for the two searchlights. For harbor use an oil-driven dynamo is placed in the forward auxiliary machinery compartment, where also are situated the forward air compressor and the ice-making plant, which is also arranged for magazine cooling purposes in conjunction with the thermo tank ventilators, which are also arranged for cabin and crew ventilation. The after air compressor is situated in the dynamo room. Both are of Whitehead design.

The armament consists of four 4-inch high-velocity guns, designed and supplied by the Bethlehem Steel Company, who, it will be remembered, supplied the armament for all the vessels built for the Argentine Government under their 1910 programme. The guns are of a heavy and powerful type, using fixed ammunition with a long pointed shell of 31 pounds and nitro-cellulose powder. The muzzle velocity is

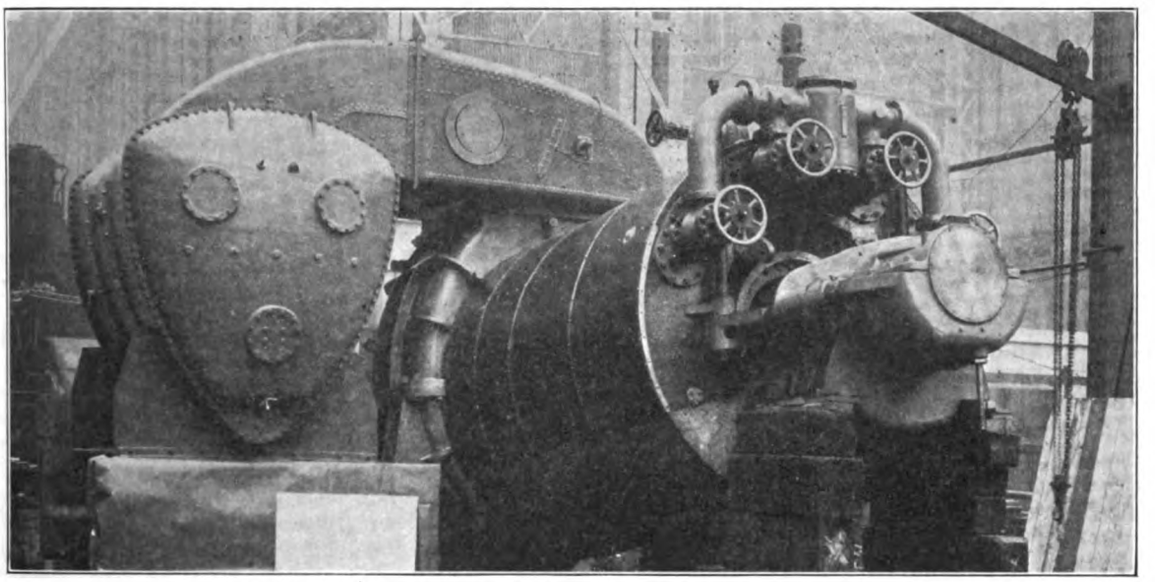

Fig. 2.—Turbine and Condenser Assembled

Fig. 3.—One of the 32-Knot Destroyers Built in England for the Greek Navy

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3,100 foot-seconds, and the range at 5 degrees elevation 7,970 yards. At just over 9 degrees the average range of twelve shots proved to be 10,768 yards. The Bethlehem "two-hand" elevating and training mechanism is fitted, as well as the company's "Rock Bar" cross-connected sights. Ammunition hoists, operated by electric motors, are fitted to both magazines, alternative hand gear being provided.

The torpedo armament consists of four 21-inch tubes of Whitehead Fiume design. Spare torpedo boxes are carried on the upper deck in close proximity to each tube, and are so placed as to permit of the tubes being reloaded with the spare torpedoes without lifting being required, as the boxes are adjacent and in line with the fore and aft position of the tubes.

The crew of 90 men, including petty officers, are berthed forward on two decks. A sick bay is provided, but seems an unnecessary refinement in view of the probable frequent presence of the almost essential parent ship. Elaborate ventilating arrangements—hot and cold air—are supplied throughout. Aft are found the wardroom, the captain's day and night cabins and private bath room, and five other two-berth cabins for the officers, who also have a bath room provided.

An elaborate system connects all the compartments, and is also fitted to the gun and torpedo tube positions. The wireless telegraphy installed has a range of 250 miles. It receives current through a converter run off the main lighting circuit. Four boats are provided—two dinghies, one whaler and one motor boat.

The general appearance of the vessels is not enhanced by the adoption of one funnel to each boiler. With the side torpedo tubes and boxes and the numerous array of stokehold cowls their appearance is a distinctly heavy one, and a better looking ship would have been obtained with three funnels. As is so often the case with minor navies, the attempt appears to have been made to embody too much in one design, though this can hardly be attributed to the builders, who appear to have fulfilled the exacting conditions laid down by the Argentine authorities, though without much to spare. That the boats have acquitted themselves well under service conditions is a tribute to their reliability and strength of construction, for all four have been constantly at work.

Prior to the purchase of these vessels the Greek Government placed orders in Germany for half a dozen 125-ton torpedo boats of 25 knots speed, which are expected to be delivered this year. If, as certainly appears to be the case, the *Lion* class destroyers are too large and too costly for the Greek service, it may reasonably be imagined that torpedo boats like these are too small, and that a better design altogether for their purposes would have been a boat of between 400 and 500 tons, somewhat on the lines of an improved *Sphendoni* type.

PIER CONSTRUCTION AT BALTIMORE.—Prior to the Baltimore fire in 1904, that city owned practically none of its water front, and municipal water front development was slow and expensive After the fire, however, steps were taken toward a definite policy under the direction of the Burnt District Commission, and $10,000,000 (£2,040,000) was raised, part of which was available for pier construction. Eight municipal piers, 200 feet wide and varying in length from 551 to 1,450 feet, have been built, and another is under construction.

PONTOON BARGE BUILT ON THE ISTHMUS.—The largest vessel ever built on the Isthmus of Panama is a pontoon barge 378 feet long, which is soon to be launched. Seventeen shipwrights and sixteen calkers were brought from shipyards on the North Atlantic Coast of the United States for the construction of this barge, while eighty-seven negro helpers were recruited from the regular forces of the Canal Commission.

International Engineering Congress, 1915: The Section of Naval Architecture and Marine Engineering

BY PROF. W. F. DURAND*

Readers of INTERNATIONAL MARINE ENGINEERING and engineers generally are already informed of the fact that it is planned to hold in San Francisco in 1915, in connection with the Panama-Pacific Exposition, a general international engineering congress to which engineers throughout the world are invited, and to the transactions of which it is planned to obtain the most eminent engineers in the various subjects as contributors, either as authors of papers or of discussions.

This congress is held under the auspices of the five oldest national engineering societies, viz.: the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the Society of Naval Architects and Marine Engineers, and the work of organization and management is in charge of a general committee representing these five societies.

It is planned for the papers in general that they shall be of such a character as to give a summarized view of the recent progress, present status and trend of progressive practice in the various lines of engineering activity, and thus present, in a wide and comprehensive view, a summary of the world's recent progress and present status in all important fields of engineering work. It is believed that papers dealing with specific problems or particular and individual pieces of engineering work may more suitably find their place in the annual proceedings of the various engineering societies, and that the occasion of a great engineering congress furnishes an appropriate opportunity for the rounding up of a practice and progress throughout the past decade and the taking of stock in matters of present status and tendency.

The general field of engineering work for purposes of the congress is divided into eleven sections, as follows, and it is planned that in the main there will be a volume of transactions for each section. The plans of the sub-committee on papers have now developed to such a point that it is possible to place before the readers of INTERNATIONAL MARINE ENGINEERING a comprehensive outline of the papers proposed for the section of Naval Architecture and Marine Engineering. The papers are twenty-two in number, with titles and condensed outline of treatment as follows:

SYLLABUS

(1) *Naval Architecture, Ship Calculations, Resistance and Propulsion*—Under this topic it is desired to note the important lines of advance in:

1. Static theory and problems with special reference to the various ship calculations, stability methods, treatment of special problems, as, for example, stability under damaged conditions or with liquid cargo, etc., etc.

2. Dynamic theory and problem, with special reference to the important advances which have been made by experimental methods in matters connected with the resistance and propulsion of ships and in the study of special problems, such as the resistance of submarines or of other special forms, of appendages, the influence of form characteristics on resistance, the best characteristics for propellers of low pitch ratio for direct connection to turbines, etc., etc.

(2) *Large Passenger Liners*—This topic is intended to cover in a comprehensive way the advances which have been made during the past decade in the characteristics of ocean passenger liners, with special reference to size, strength, peculiar structural features, speed, carrying capacity, general

*Chairman of the committee of management.

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accommodations, propulsive and auxiliary machinery and safety, with due regard to the more specialized treatment of this subject, under topic No. 16.

(3) *Ocean Freighters*—This topic is intended to cover for this class of ships the progress made during the past decade and the present status in matters relating to size, speed, cargo capacity, structural characteristics and safety, with due regard to the more detailed treatment of this subject under topic No. 16. In this paper the subject of cargo-handling devices need only be given incidental reference. See topic No. 11.

(4) *Passenger and Freight Steamers for Service on the Pacific Ocean*—This paper is intended to give a comprehensive resumé of recent practice in the design and construction of steamers for service on the Pacific Ocean and including the use of oil fuel. The paper will include due reference to size, speed, power, cargo and fuel capacity, special structural features, propulsive machinery, etc., with special reference to the conditions imposed by transpacific service. The subject of safety should be treated with due regard for the more detailed consideration of this subject under topic 16.

(5) *Great Lakes Freighters*—This topic is intended to cover for this type of construction the recent progress and present status in matters relating to size, carrying capacity, speed, propulsive machinery, auxiliary equipment, strength and principal structural characteristics. The subject of cargo handling need be given only incidental reference. See topic No. 11.

(6) *Yachts and Pleasure Craft*—This topic is intended to cover for this general type of construction the recent progress and present status in matters relating primarily to size, speed, accommodation, cruising radius, strength, structural characteristics, propulsive machinery and auxiliary equipment and safety, with due regard to the more detailed treatment of this subject under topic No. 16. This subject is intended to include the use of the internal-combustion engine as a prime mover for all types of pleasure craft and with special reference to the field of the motor boat.

(7) *Light Draft Sound and River Boats*—This topic is intended to cover for this general type of construction the recent progress and present status in matters relating to size, capacity, speed, propulsive machinery and auxiliary equipment, strength, peculiar structural features and methods of cargo handling peculiar to the type of boat.

(8) *Warships of First Line Battle*—This topic is intended to cover for the general fighting unit of the first line of battle the recent progress and present status in matters relating to size, speed, cruising radius, propulsive machinery and auxiliary equipment, strength, peculiar structural features and safety, with due regard to the more detailed treatment in paper No. 16. The subject of armament, offensive and defensive, should be covered in a broad manner and with regard to the more detailed treatment which is to be given to these subjects under topics Nos. 18-21.

(9) *The Torpedo Boat, the Destroyer and Cruiser Destroyer Types*—This topic is intended to cover for this class of construction the recent progress and present status in matters relating to size, speed, cruising radius, propulsive machinery and auxiliary equipment, peculiar structural features, strength and safety, with due regard to the more detailed treatment of this subject under topic No. 16. The general subject of armament, offensive and defensive, should be covered in a broad manner and with due regard to a more detailed treatment of these subjects under topics Nos. 18-21.

(10) *The Submarine*—This topic is intended to cover for this type of construction the recent progress and present status of matters relating to size, maximum depth of operation, maximum time of immersion, cruising radius, speed on the surface and immersed, leading structural features, propulsive machinery, auxiliary equipment, navigational appliances for use when immersed, armament, offensive and defensive, with due regard to the more detailed treatment of these subjects under topics Nos. 19-21.

(11) *Cargo-Handling Methods and Appliances*—This topic is intended to cover in a summary manner the general subject of cargo handling, both from the dock to the ship and the reverse, and by means of equipment located both on the dock and on the ship. The space available will require limitation to the important lines of progress during the past decade and the present most approved devices and methods. It will naturally cover the field of dock cranes, stationary and traveling, ship hoists of various types, size and arrangement of hatches, and other features bearing on the same general problem.

(12) *Fuel Oil*—This topic is intended to cover the important lines of progress during the past decade and the present most approved practice in connection with the marine uses of fuel oil. The discussion will naturally include atomization by means of air and the recent advances which have been made in atomization by mechanical means, together with suitable mention (having due regard of their relative importance and function) of the general items of a complete oil-burning installation for marine use. If practicable, the papers should include economic results showing the status of oil burning as a factor in the economy of ship operation.

(13) *Application of the Steam Turbine to Marine Propulsion*—This topic is intended to cover the recent practice and a broad view of the present status of the general use of the steam turbine as a prime mover for ship propulsion. The treatment will naturally include the use of turbines by direct drive to the propeller, through mechanical speed reduction, or through speed reduction by the use of an electric generator and electric motor as intermediate links; also combinations of turbines and reciprocating engines with regard to various purposes and for special types of service. Advantages and disadvantages, limitations and economic results should naturally receive due attention in the general treatment of the subject.

(14) *Application of Diesel or Heavy Oil Engines to Marine Propulsion*—This topic is intended to cover the remarkable progress in the application of this type of prime mover to the demands of marine service which has characterized the last decade. The paper will naturally include reference to size of ship, power and weight of propulsive machinery, revolutions, methods of starting and reverse and other special characteristics required for marine use. An important section of the general subject relates to the question of reliability under the conditions of marine service, the cost of up-keep and general reliability and availability as compared with steam prime movers. The best thermal efficiency of the Diesel engine and of engines of this type is well known. It is very desirable, however, that some information should be given, if practicable, regarding fuel economy under general service conditions.

(15) *Marine Boilers and Boiler Room Equipment.*—This topic is intended to cover the important lines of progress and the present most approved practice with regard to the design, installation and operation of boilers and boiler room equipment. From the nature of the subject, the treatment need not be exhaustive and will naturally cover only the important lines of progress during the past decade. The treatment of the topic will naturally include references to advancing steam pressures and their influence on design, operation and maintenance; to the use of the firetube boiler, as, on the whole, distinctive of mercantile practice, and of the watertube boiler as still more definitely distinctive of naval practice, and to the extent to which the latter type has gained acceptance in the mercantile field; to superheating and the use of superheated steam; to methods of mechanical draft, of feed-water supply, of the handling of ashes and refuse, of the handling of coal

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from bunkers to furnaces, of clock-regulating firing, of special developments relating to corrosion and deterioration, of improved methods of air supply and baffling, of the application of flue gas analysis and other features having reference to improved economy or control of boiler room conditions.

(16) *Safety at Sea*—This topic is intended to cover in a summary manner the more important matters relating to safety at sea, with note of the important lines of progress during the past decade. The paper will naturally be divided into a discussion of those factors which relate directly to the safety of the ship as such, and means for the saving of life in case of accident rendering the ship no longer seaworthy. Under the former head reference will naturally be made to the International Conference on this subject recently held in London and to the discussions and recommendations resulting therefrom. Under the latter head reference will naturally be made to the various auxiliary and secondary means, including lifeboats, liferafts, wireless telegraph equipment and other means of signaling, searchlights and other means for the detection of icebergs or derelicts at a distance, etc., etc.

(17) *General Problem of Naval Warfare*—This topic is intended to cover a discussion on broad lines of the general problem of naval warfare, including reference to the function of the various fighting units, battleships of the first line, battle cruisers, destroyers, torpedo boats, submarines, etc.; questions of the relative importance of weight of fire, speed and endurance; special combinations of characteristics in the various fighting units; distribution of offensive and defensive features, etc., etc.

(18) *Marine Gun Armament*—This topic is intended to cover recent progress in and the present status of modern marine gun armament in the various types. With reference to the typical heavy gun, the treatment should include a discussion of the features which have brought about so complete a change, and with such relative suddenness, from guns of about 12 inches caliber to those of 14 inches or more; likewise due consideration of the problem of massing and handling two or more such guns in turrets, and such further treatment of the turret as may be necessary for the main purposes of the paper, but without detailed consideration of the turret covering, as armor plates. (See topic No. 21.) The treatment should also include due reference to the problems of handling, recoil, control, erosion and other characteristic features of modern heavy, high-powered guns.

Gun armament of the intermediate and light caliber, and all types of quick and rapid-firing guns, may be treated in the same general manner, including due reference to the characteristics, capabilities, effective life and performance of the various classes of such armament.

(19) *The Marine Torpedo*—This topic is intended to cover recent progress in and the present status of the automobile torpedo as a weapon of offense. Improvements in motive power, in methods of launching, in directive control, in length of range and in character and power of explosive charge will naturally form the principal items of the treatment.

(20) *The Projectile*—This topic is intended to cover the recent progress in and the present status of the projectile used in marine guns of various types, but with special reference to those for heavy armor piercing service. The paper will naturally include a discussion of the contest between the armor plate and the projectile, and of the possibility of carrying charges of high explosives through modern armor and of exploding them in the inside, and of the problems of fusing and of projectile design and manufacture which these requirements entail.

Due reference should also be made to standing and r. f. ammunition for various types of gun and various demands of service.

(21) *Defensive Armor*—This paper is intended to cover the general field of defensive armor, its technical characteristics, its capabilities for stopping or breaking up modern projectiles, its distribution on shipboard on ships of the various types, improved methods of fabrication, improved forms and methods of backing, of attachment to the ship, etc.

(22) *Modern Naval Target Practice: Methods and Results*—This paper is intended to cover the astonishing advances which have been made in recent years in the methods and results of modern target practice.

The paper will naturally include reference to methods of gun and turret handling, of sighting, of fire control, of drill with stub and full caliber practice, with results as shown by recent records.

Of these various topics, Nos. 18, 19, 20, 21 and 22, relating to naval armament, must necessarily be treated with the reserve as to detail characteristic of such matters. The committee hopes, nevertheless, to obtain on broad lines an interesting and valuable summing up of recent progress and present status in these important lines of engineering work.

In addition to the regular ten volumes of transactions containing the professional papers and discussions, and which it is planned to publish in the standard 6-inch by 9-inch size, and of about 500 pages each, there will be published a somewhat smaller volume as to number of pages and containing all general proceedings of the Congress, together with a full index and carefully prepared digest or abstract of all papers published in the ten volumes of transactions.

Engineers and all who are interested in engineering work are invited to become members of the Congress. It is hoped, of course, that a very large number of those subscribing to membership will be able to attend the Congress in person, but such attendance is not to be considered as in any way necessary as a condition of membership. The membership fee has been placed at $5.00 (1/0/10), which will entitle the subscriber to the general proceedings and index digest volume, together with any other single volume of the transactions according to choice, and to the right to purchase additional volumes at a reduced price, varying with the number ordered.

The opportunity thus presented for engineers to acquire, at the minimum cost, a series of volumes dealing in this authoritative manner, with the various leading branches of engineering work, is one which those interested in such work cannot afford to overlook.

Circulars giving further detailed information, together with blank forms for membership application, will be gladly sent on application to the secretary, Mr. W. A. Cattell, 418 Foxcroft building, San Francisco, Cal.

A Large Floating Dock Built in England for Argentina

In connection with the rapid development which the Argentine Republic is effecting in connection with its sea-going interests, an excellent example of floating dock has recently been constructed by Messrs. Vickers, Ltd., of Barrow-in-Furness, to the order of the Argentine Government.

This dock is shown in Fig. 1, illustrating its sea passage under tow, and in Fig. 2, which shows it engaged in docking a steamship. It is of the box or solid type, the principal dimensions of which are as follows:

Length overall	300 feet
Extreme breadth	60 feet
Width between walls	43 feet
Depth from the top of the wall to the bottom	28 feet 4 inches
Depth of pontoon	6 feet 11 inches

The dock is designed for lifting vessels of about 1,500 tons displacement and on its trials it was found that the dock lifted a vessel of this weight in no less than 100 minutes from the

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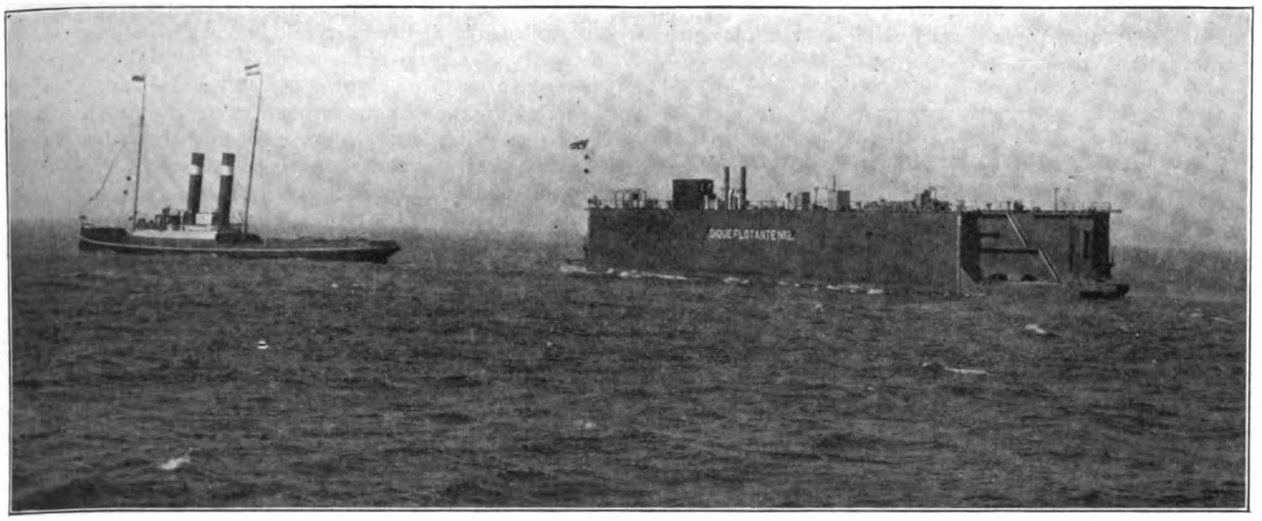

Fig. 1.—Argentine Floating Dock Being Towed to Its Destination

time that the vessel touched the keel blocks until the pontoon of the dock was clear of the water.

The dock is subdivided into 18 watertight compartments and a branch is led from each of these compartments to the main drain. In this way a single complete pumping installation is fitted throughout the dock. The pumping machinery consists of two centrifugal pumps driven by single cylinder engines placed in a compartment below the top deck in one of the walls. The control of the dock is centralized in a valve house, from which point the dockmaster has control of all the valves, engines, etc., throughout the dock. The lighting of the dock is effected by electricity throughout and means are provided for supplying current for lighting purposes of any vessel which may be at the time in repair at the dock. Electric fans are also provided for ventilating the engine and boiler-room.

Mechanical side shores operated from the top deck are fitted for steadying the vessel in position on the deck during the time that repairs are being effected, and in order to facilitate speedy repair work a steam traveling crane is fitted on one of the walls. At one end of the dock there is a gangway ir order to provide communication between the two side walls and

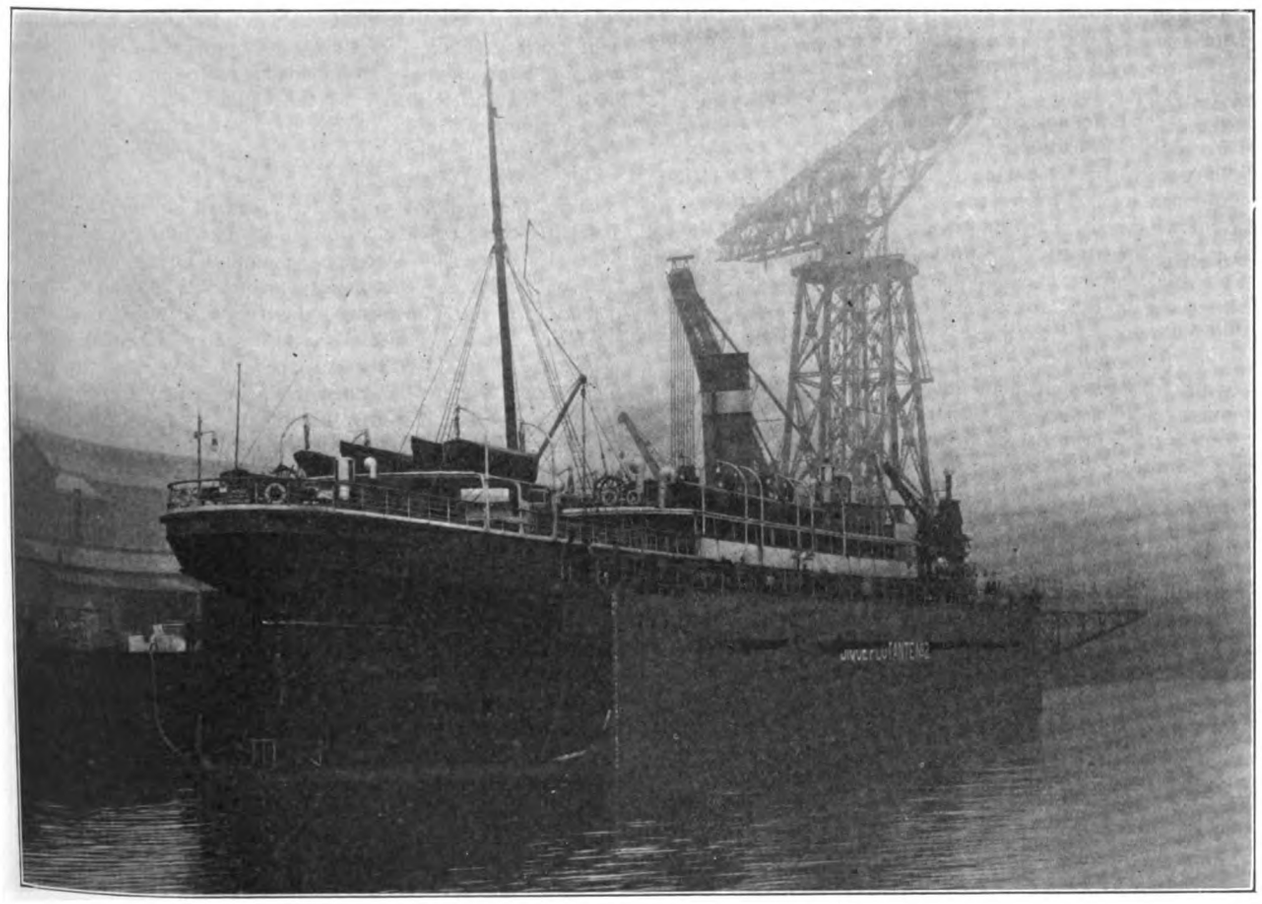

Fig. 2.—Steamship Docked in New Argentine Dock

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means are provided by which the dockmaster in the valve house is kept continually informed of the amount of water in each watertight compartment.

The Control of Electric Motors on Warships*

BY C. L. PERRY

The use of electric motors on shipboard in the United States, if we neglect certain equipments which were in the nature of experiments, began with the equipment of some 8-inch ammunition hoists on the battleships *Indiana*, *Massachusetts* and *Oregon* about the year 1894. Since that time the use of electric equipments on naval vessels has steadily increased, until to-day they have almost supplanted steam for every purpose except engine-room auxiliaries and actual propulsion, and even the latter is being seriously considered. The number of installations on merchant vessels flying our flag has been insignificant compared with the number in the Navy, and in this article only the latter will be considered in detail.

As a result of naval influence nearly all marine control equipments are of special character embodying features rarely called for in industrial practice, and in point of safety distinctly in advance of the latter. The two most important general requirements for continuously-running motors are, first, no-voltage protection for all size of motors; and, second, the requirement that unless starting rheostats are designed with practically continuous capacity, the control equipment must be such as to render it impossible to leave the motor running with resistance in circuit with it. Water-tight and flame-proof covers are also required in many places.

In order to meet the no-voltage and resistance requirements it has frequntly been found better to use separate overload circuit-breaker panels with contactors mounted on them for no-voltage protection, connected with drum controllers having special contacts for the operation of the latter. The latest of these controllers have hinged handles which have a slight vertical movement as well as the usual rotary movement. The vertical movement operates a contact which closes the energizing circuit of the contactor, the main contacts of the latter being in circuit with the motor. In case the handle is released before the running point of the controller is reached, or in case of no-voltage, the contactor opens and cannot be closed until the handle is returned to either the "off" or first position.

Aside from these general special requirements the many unique uses of motors, such as training and loading the guns, forced draft blowers, steering gears, etc., require special features. Some of these will now be considered in greater detail.

Turret and Ordnance Control Equipment

In a turret the guns are controlled in a horizontal plane in pairs by the rotation of the turret, though their range may be separately adjusted by the elevating motors. In some of the turrets recently designed, the ammunition is first hoisted from the lower handling room in the magazine to an intermediate compartment; and there slid from the ammunition car of the lower hoist to the car of the upper hoist, which is then raised to the breech of the gun. This arrangement has been adopted on account of the danger of burning powder bags or other materials falling down into the magazine when a through passageway exists; although this danger is sometimes avoided by having doors in the passageway which close automatically.

Three different methods of control have been used successfully for ammunition hoists, each being a step in the development of this class of apparatus. The first was a dial-type controller arranged for dynamic braking in lowering; and the second was a plain drum controller for a shunt motor arranged so as to give power as well as dynamic braking in lowering the car. In one system, during lowering, a resistance —part of which is used during hoisting—is connected across the line, and the motor armature is then connected across sections of this resistance so as to gradually increase the potential across it. Such equipments are in use on a great many of the older vessels, which were furnished with a single hoist from the lower handling room to the gun. Their chief limitations were that the amount of current which could be handled greatly limited the speed of operation; and that it was difficult to locate a large drum controller beneath the gun-room deck, and still be able readily to operate it.

In the U. S. S. *Michigan*, *Florida* and *Utah*, systems of automatic control with master controllers, magnetic switches and limit switches were developed. The limit switches are so designed that the carriage is slowed down and stopped without any attention on the part of the operator. This is necessary on account of the extremely rapid operation required, the trip from the lower to the upper handling room usually taking from five to eight seconds, according to the height of the turret, and the trip to the gun taking about seven seconds, the latter depending slightly on the elevation of the gun. On these ships it was considered desirable to retain current on the motor as long as the car was up, and compel it to follow the motions of the breech, which introduced several additional complications. On some of the latest ships automatic electric control has been abandoned in favor of clutches driven by electric motors, the change being made for sake of simplicity. This method also overcomes, to a considerable extent, the trouble sometimes experienced with the slacking of hoist cables caused by motor armatures not stopping quickly enough; as the latter, on account of their high momentum, are difficult to stop accurately in a short space of time.

The next apparatus to consider is the rammer. This may be either of the telescope or the chain type. The former, as the name indicates, consists of a series of concentric tubes which are extended by means of an arrangement of chains and pulleys. The chain type consists chiefly of a large block chain, the links of which have square corners on one side so that they can bend in only one direction. Both types are usually driven by a compound wound motor, and except in a few recent ships no attempt at automatic control has been made, the operator being relied upon to check the speed as desired. In some special cases, however, automatic rammers have been used with very satisfactory results. In these a limit switch controlled through the agency of differential gearing jointly by the controller and the motor was used. The length of the rammer stroke could then be controlled by the position of the controller handle—a desirable feature when it is appreciated that the length of the stroke, for the shell, may be double that for the powder bags. Having loaded the gun the next step is to screw in the breech block, which in some cases is also done by a small motor.

During all these operations the men in charge of sighting the guns are busy. The electric range-finder has given the distance and the turret has been turned to the proper angle. The latter operation is an exceedingly delicate one, and a great many systems have been proposed for getting the necessary results. The first used on the older ships was a voltage control system, a separate generator or motor-generator set being employed for each turret. In its simplest form a single motor drove the turret throughout its entire range of speed, and was controlled by varying the field of its generator. The regulation was not entirely satisfactory, however, and this was superseded by what is known as the rotary compensator system. In this, two armatures having independent fields are

*From the *General Electric Review*.

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mounted on one shaft and connected in series; and two motors, one of much larger capacity than the other, are connected across the terminals of the armatures of the rotary compensator. The speed of each motor is then regulated by varying the field of its counterpart in the compensator. These fields are connected in series across the feeders, their common middle connection being attached to the arm of a field rheostat, the resistance of which is also across the feeders.

With this arrangement, and the use of electric clutches for the small motor, the full speed range of both motors can be made use of; and it has the great advantage over the use of a single motor, in that the slow speeds are far more stable and are accompanied by better torque. Nevertheless it does not give quite ideal results, as it has been found impossible to obtain with it a straight line speed curve; for the reason that the speed changes of the large motor are too small at some points and too large at others. Another system in use consists of two motors driving a differential gear, the speed of the turret being obtained by varying the field strength of the two motors. This system has given good results; but the difficulty of electric control, due to the self-induction of the field magnets and the inertia of the armatures, has led to the preference for hydraulic speed gears, driven by constant speed motors.

The elevation of the guns is a simpler matter and is accomplished by a motor and hydraulic speed gear. The relative capacities of motors used in the turret are of interest and are shown in the following table for the U. S. S. *Florida*:

	H. P.
Upper ammunition hoist	60
Lower ammunition hoist	25
Rammer motor	7
Elevating motor	15
Breech-block motor	3.5
Turret-turning motors for hydraulic gear	25

Boat Crane Controllers

Boat crane controllers, since they must of necessity be exposed to the weather, are made water-tight. Each contains as a rule two cylinders, one for hoisting and one for swinging the boat over the side. They also contain magnetic blow-out circuit-breakers, which can be set by handles extending through the covers and tripped by push-rods passing through stuffing glands. The hoisting cylinders usually operate by rheostatic control, the load being held by a spring-operated magnetic disk brake when the controller is at the "off" position, or in case of failure of voltage; and an excessive speed in lowering is prevented by an automatic mechanical brake. In the latest types the lowering control is electrical rather than mechanical, and makes use of a principle similar to that in ammunition hoists. The cylinder for the rotating motor is generally arranged like the older ammunition hoists. Hoisting motors for boat cranes are usually of 50 horsepower capacity; while the rotating motors are usually about 30 horsepower to 40 horsepower.

Forced Draft Blowers

The control of forced draft blowers would require no consideration here if only one blower were used for each boiler room, and the space for the motor and equipment were less limited than they are on shipboard. These two conditions, however, add certain elements of risk which must be taken care of by special means.

It is characteristic of two properly-designed blowers, of like capacity, acting together, that they will divide the load equally; but that if either stops, the load on the other will at once increase. We must also remember that the blower motor speeds must be varied according to steaming conditions, and to do this economically the field strength of the motors are varied. If now, while two blowers are running at full speed, one of them is stopped, the other immediately becomes overloaded; but its load can be reduced by simply strengthening the field of its motor. This is done by the use of an overload relay which short-circuits the field resistance. Controllers for forced draft blowers sometimes have a further complication on account of the necessity of operating them from more than one point. Under these circumstances, if it is also required that the special handle and contact, spoken of above, be employed, the circuits become quite complicated.

Steering Gear Control

Electric control of steering gear has been studied almost from the beginning of the use of electricity on shipboard, but the necessity for absolute reliability combined with extremely severe service has, until recently, prevented its use except in a few experimental installations. The improvement in the reliability of control apparatus has of late, however, brought this matter into prominence, and several recent ships are now being equipped with electric steering gears. In general, most systems include some form of follow-up device; i. e., a device so designed that as the rudder turns it will cut power off the motor which turns it. This feature in an analogous form has been almost universally applied to steam gears; and since the latter also will be installed as alternative means of steering on the ships which are to have electric gear, it is natural to insist that the same method shall be employed for control by either system. This can be accomplished by a wire rope transmission or by means of a device known as a telemotor. This consists of two cylinders containing pistons, and connected together by piping on both sides of the pistons. If one piston is moved the other will be forced to move also, and can be used to operate either a steam valve or a master controller. This arrangement eliminates all wiring between the steering stand and the electrical apparatus.

In other systems a pilot motor control is used between the steering-stand and the main controller; while in others a Wheatstone bridge arrangement is employed for controlling the exciter of the special generator which furnishes power to the rudder motor. In still others no follow-up device is used, depending on an indicator to show the position of the rudder. Aside from these features of remote control it is interesting to consider the mechanical characteristics of this problem. We must appreciate in the first place, that, to maintain even an approximately straight course, the rudder must be shifted constantly, seldom remaining in a fixed position for more than a few seconds. This necessitates constantly reversing the operating motor, which means the severest kind of service for the controlling apparatus. Another difficulty is the extremely variable load, which may change from a very small value to 100 percent overload an instant later. Fortunately the reversal of torque can be controlled to some extent by operating the rudder through the agency of a large screw having right and left threads at opposite ends, these threads carrying nuts to which links are attached which act on a cross-head on the rudder. The pitch of the threads is small enough to prevent the rudder from driving the screw, and consequently there will be but a very slight tendency to drive the motor even with the screw turning rapidly. Even with this arrangement a shunt around the motor armature can be employed to good advantage in order to stop the rudder quickly, when the pressure of the water and the momentum of the motor are tending to drive it.

Steering gears for large ships require as high as 300 horsepower for short periods; and since 120 volts is used on all American ships the current is very large and requires the use of magnetic switches. In the Argentine Navy 220 volts has been adopted, which has considerably lightened the equipments on the two ships now being furnished with electric gear.

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Tug and Passenger Tender Flying Kestrel

Description of an Interesting Vessel Fitted for Passenger Service on the Mersey or for Deep Sea Towing and Salvage Work

Fig. 1 shows an interesting type of steel screw tug and passenger tender, the *Flying Kestrel,* which was built by Messrs. J. T. Eltringham & Company, of the Stone Quay, South Shields, to the order of the Alexandra Towing Company, Ltd., of Liverpool. While embodying the latest improvements in design and fittings for the conveyance of passengers to and from the large liners frequenting the Mersey, this vessel will also be capable of undertaking long voyages in connection with towage or salvage work.

The *Flying Kestrel* has an over-all length of 153 feet, and its beam is such as to ensure stability when carrying a full complement of passengers on the promenade deck. The propelling machinery consists of powerful triple-expansion engines, supplied and fitted by Mr. George T. Grey, of South Shields, steam being supplied by two large multi-tubular boilers, built by Messrs. Eltringham, and working at a pressure of 180 pounds per square inch.

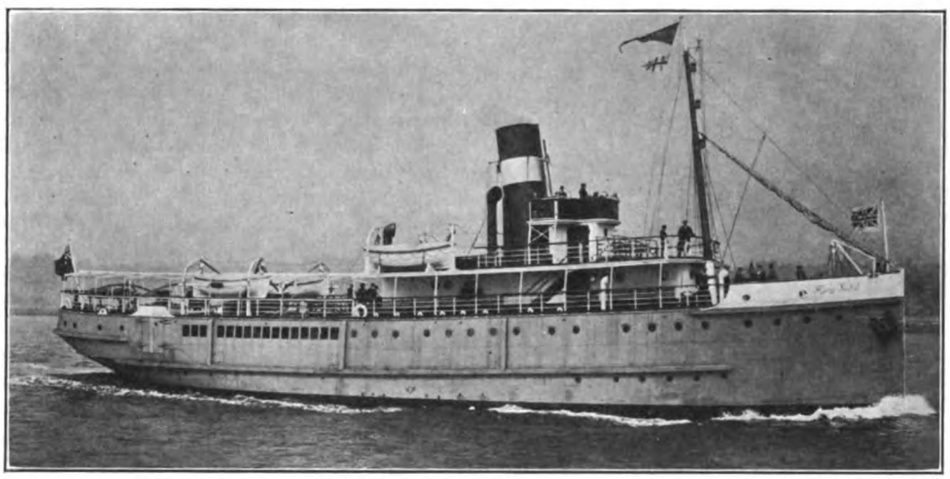

Fig. 1.—Passenger Tender and Tug *Flying Kestrel* for Atlantic Liners at Liverpool

The general arrangement of the vessel has been evolved from the long experience of the builders and owners in several somewhat similar but smaller craft. There are five decks—the lower, main, promenade, bridge and flying deck, the last-mentioned being on top of the chart house, and having a steering wheel and standard Morse signal lamp, two engine-room telegraphs of the repeating type, and a Kelvin & White standard compass fitted.

Below this is the bridge deck, with chart house, containing the electric light switches for the navigation lights and cargo clusters, and an inter-communication telephone system connected with all parts of the ship. On the deck are stowed two of the four boats provided for life-saving, and there are also large teak life-belt boxes placed alongside the coaling hatch. Forward of the charthouse the deck is fitted with teak doubling, and there are sliding gangway openings in the rails for landing passengers from the large liners.

By two wide stairways leading down at an angle of 40 degrees access is gained to the promenade deck below, this being the principal passenger deck, and constructed so as to be measured by the Board of Trade for passengers the full width of the ship. On this deck, right aft, is the hand-screw steering gear and standard compass, to be used in case of failure of the steam steering gear, and forward of this on either side is a large hatch with removable teak top through which passengers' luggage is lowered to the main deck. Forward of the aftermost tow-rail is fitted a large teak grating for the stowage of the towing ropes, which are handled by a very powerful steam capstan fitted with a barrel of extra large diameter, this capstan being used also for warping purposes when required. Forward of this, again, is a very large teak companion with double-slipping top covering the stairway to the after main deck, and alongside are carried two other lifeboats slung in davits and lashed against a pole with special leather-covered pads to prevent damage to the boats. Further forward, on each side, are two specially designed openings in the rails with teak doubling on the deck for landing passengers, two gangways fitted with rollers and india rubber treads being provided for this purpose.

On this deck there are three very strong tow rails, with portable side pieces fitting into strong sockets on the rails, the latter being made of great strength and connected all around by a heavy angle bar surmounted with a teak rail. The towing gear, consisting of two strong slip hooks working on a semi-circular tow-bar, is connected to the aft end of the deck casings, and when not in use the gear is covered by a semi-circular teak seat constructed so as to be easily removable.

The deck casings on this deck contain two staterooms tastefully fitted out in polished oak, each having a folding bed, also sofa with drawers under, cabinet folding wash basin, and steam heater, while at the forward end is a large deck house entrance to the main saloon, with a wide oak staircase, the steps of which are fitted with fluted india rubber treads and brass nosings.

At the extreme fore end of the promenade deck there are two large warping capstans and cable lifters for handling the heavy stockless anchors, the machinery for working which is situated on the main deck below, and access to the engine is gained from a steel companion. This machinery is so arranged that it can be worked either from the promenade deck or the main deck.

From the deck house, previously mentioned, the stairway leads to the main saloon, this being handsomely fitted in two

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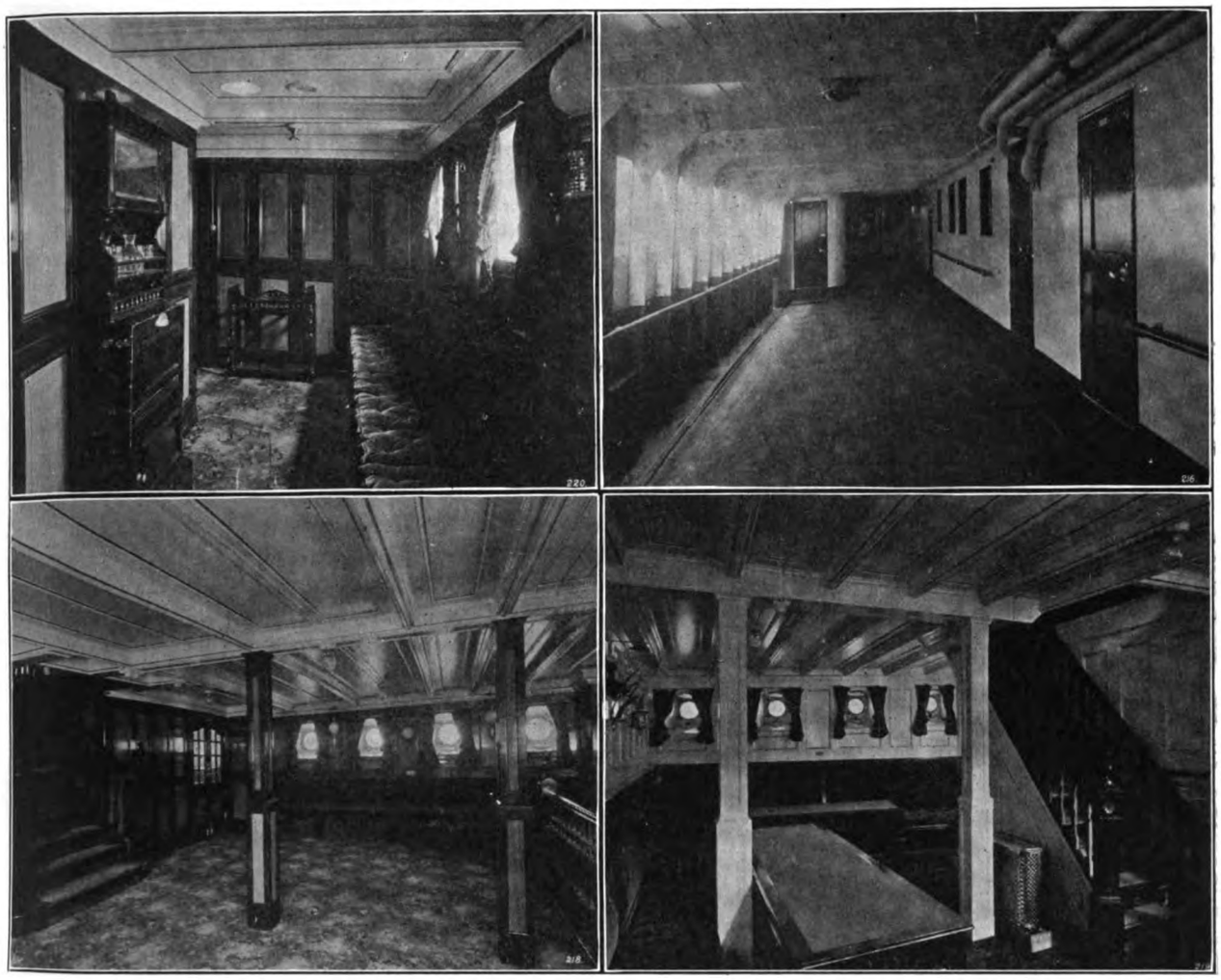

Fig. 2.—Part of Ladies' Saloon
Fig. 4.—Main Deck Saloon

Fig. 3.—Main Deck, Looking Forward
Fig. 5.—Dining Saloon

shades of polished oak, an Axminster carpet fitted on thick felt being laid on the deck. The upholstery is of dark blue velvet, and in conjunction with the side-light curtains of old gold damask and electro-plated fittings, gives to the whole a very handsome appearance. The system of steam heating and electric fan ventilation ensures comfort in all states of the weather.

From this saloon tastefully designed swing doors with beveled glass panels lead on the port side to the smoking saloon, and on the starboard side to the ladies' saloon, these being fitted in a style corresponding to the main saloon. At the fore end of the main saloon a staircase leads to the under deck saloon, which is fitted with folding beds, so arranged that they are housed behind the seat backs when not in use. This saloon may also be used as a dining saloon, four large tables being fitted for this purpose, and there is also a heating and ventilation system of the same kind as in the saloon above.

After passing from the deck saloon access is gained to the main deck through the smoking saloon, there being side houses fitted containing lavatories for passengers and crew, also the various storerooms, pantries, etc. In the main deck casings are contained the galley, entrance to engine room, crew space, officers' quarters and large cupboards containing the life-belts for the use of passengers in case of emergency, while right aft there is a steel bulkhead across the full width of the ship, forming a separate compartment for the steam steering engine, in addition to a large storeroom and lamp-room.

At each side of the main deck aft there is fitted a specially designed double steel door, made to hinge outwards, and used in connection with the hatch above on the promenade deck for the purpose of taking on board passengers' luggage, which is thus very quickly placed in a position secure from bad weather.

At the official trials a speed of over 12 knots was attained. and the maneuvering qualities of the vessel were demonstrated in a very satisfactory manner.

The Rolling of Ships

BY ARTHUR R. LIDDELL

The rolling of a vessel is brought about by a succession of impulses given by the waves at regular intervals of time much in the manner of those applied to a garden swing. The resistances of the parts of her outer surface above and below the loadline are much the same in degree, and provided the impulses be given at intervals of time which synchronise with her period, the oscillations will steadily increase in amplitude until some disturbing influence other than that of the surface friction of the outside plating intervenes. The fitting of bilge rolling keels increases the proportion borne by the total resistance to the force of the periodic impulse, and thus lengthens the time during which the vessel rolls up to a given angle of heel, but it does not alter her period of rolling to any considerable extent. Only the amplitude of the individual oscillations is reduced by it. An additional resistance, which

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acts intermittently, comes into play after the deck has become immersed. A wedge of water is then raised and thrown off at each side or across the deck, the effect of which in retarding the motion is intermittent, and thus differs from that of the constantly immersed bilge keel. The rolling motion is thereby checked, and the synchronism is disturbed more and more as the immersion of the deck increases, until the divergence of the periods of ship and waves becomes considerable. The ship then gradually becomes steady, and remains so till successive wave impulses set her going again in oscillations of increasing amplitude as before.

The check thus afforded by the sides of the deck might equally well be applied by projecting fins fitted on the vessel's sides above the water, perhaps towards the ends so as not to project beyond the extreme breadth. It may here be noted that side fenders fitted on some of the vessels plying in the Irish Sea were currently asserted to damp their rolling motions. In regard to bilge keels in the ordinary positions, there are various contrivances, such as those of cutting holes through them, fitting them with hinged flaps, etc., which might be tried with a view to the increase of their effect. It would be well if the experimenting institutions could find time to invent and make trial of devices of this nature on their own account.

Now an ocean wave of a given length has a period equal to 2.263 $\sqrt{\text{length in feet}}$; but the period of a vessel is not so readily obtained; its determination by calculation has hitherto been looked on as a very long and laborious process, and it has indeed rarely been attempted. The formula given by Sir William White for the period of a vessel is

$$T = .554 \sqrt{\frac{k^2}{m}},$$

where T is the still-water period in seconds for a single roll; m = the metacentric height ($G\,M$) in feet, and k = the radius of gyration of the vessel and her cargo in feet.

The factor which varies most in the foregoing is the root of the metacentric height, but this may be calculated, found by direct experiment, or assumed; the radius of gyration, or $\sqrt{k^2}$, has hitherto been the difficulty. The question which arises most often in practice is: with what degree of stability, as expressed in metacentric height, does a given ascertained period correspond? and before this can be answered the radius of gyration must somehow be found. Now, although an exact calculation of this radius may be a considerable undertaking, an approximate value for it, which will generally answer the desired purpose, can be more readily obtained. A loaded vessel consists in the main of a hollow steel cylinder or shell filled with more or less homogeneous cargo and inner structural parts, such as bulkheads, lower decks, etc. The radius of gyration of the shell, *i. e.*, of the outer platings and framings, will in full-formed cargo vessels approximately coincide with that of the periphery of an equivalent rectangle that is slightly narrower and perhaps shallower than the midship section of the vessel. The radius of gyration of the cargo and inner structural parts may be taken to coincide with that of an equivalent circle, ellipse, triangle or other geometrical figure the properties of which are known. The figure to be chosen for comparison in the latter case may be determined by an inspection of the midship section. It may be objected that these are mere approximations, but, as will be seen in the following, the percentages by which they are likely to differ from the realities are not so great as very materially to affect the metacentric heights that must, in vessels of given periods, accompany them. It will also appear that the error in any particular case may be reduced by the application of a combined system of calculation and observation.

The weight of the shell, including the outside plating and upper deck, and the parts of the general framing, etc., which are in immediate proximity to these, may in many cases amount to about 20 percent of the displacement; in some passenger ships and yachts it may, of course, be considerably more. The weights of the parts in question will in most cases be already known to the designer, and in similar ships they will form a fairly constant proportion of the whole weight of the hull. The remainder of the weight of the ship added to that of the cargo may then be taken to be evenly spread over the surface of the transverse geometrical figure chosen. To simplify the work, the squares of the radii of gyration of the hollow rectangles and of the surfaces of geometrical figures given in the table have been calculated:

TABLE I.—RECTANGLE ABOUT CENTER OF GRAVITY.

Proportion of Depth to Breadth.	(Radius of Gyration)² in Terms of Half-Breadth of Vessel Taken as Unity.	
	Shell.	Surface of Transverse Plane.
.8	1.093	2.186
.7	.993	1.986
.6	.907	1.814
.5	.833	1.666
.4	.773	1.546
.3	.726	1.452

TABLE II.—TRIANGLE ABOUT CENTER OF GRAVITY.

Proportion of Height to Breadth of Base.	(Radius of Gyration)² in Terms of Half-Length of Base as Unity.
.8	.309
.7	.276
.6	.247
.5	.222
.4	.202
.3	.187

TABLE III.—CIRCLE OR ELLIPSE ABOUT CENTER OF GRAVITY.

Proportion of Minor Axis to Major Axis.	(Radius of Gyration)² in Terms of Half-Length of Major Axis as Unity.
1.0	.500
.9	.452
.8	.410
.7	.372
.6	.340
.5	.312
.4	.290
.3	.272

The tabular figure must in each case be multiplied by the square of the proportion borne by the half-breadth of the vessel to the radius of circle or half-length of base, respectively. As an example of the application of the table we may take a vessel of depth to breadth = .75, with short erections and deckhouses, the equivalent transverse plane for which may be nearly equivalent to that of a circle with center at a height above the base of the squared midship section equal to half the breadth. The tabular figures are:

For the hollow rectangular 1, and for the transverse figure .5.

If the weight of the shell be taken at .2 of the whole we have

For the hollow rectangle..... $1 \times .2 = .2$
For the transverse figure..... $.5 \times .8 = .4$

For half-breadth = 1 (radius of gyration)² = .6

If the half-breadth of the vessel be 20 feet the square of the radius of gyration = $20^2 \times .6 = 240$.

Assuming a $G\,M$ height = 1 foot, the period of the vessel will be equal to

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$$.554 \times \sqrt{\frac{240}{1}} = 8.57 \text{ seconds.}$$

If the period be known and not the $G\ M$ height, the calculation for the latter will be

$$\frac{T^2}{k^2 \times (.554)^2} = \frac{(8.57)^2}{240 \times (.554)^2} = 1 \text{ foot.}$$

The question now arises: What difference the maximum probable error in the square of the radius of gyration can make in the final result? The radius of gyration of the shell cannot be greatly varied, but the approximate value for the radius of gyration of the remaining weights might perhaps be wrong by 5 percent, which would give an error of about 10 percent for the (radius)^2; the (radius)^2 for the whole weight in the above calculation would then vary between .56 and .64, or by about 7 percent from the mean value .6, and the $G\ M$ height in the same proportion, *i. e.*, by less than 1 inch. The difference of the period, which varies with the simple radius of gyration, would then be about three seconds.

Assuming the perhaps improbable error of 10 percent instead of 5 percent for the radius of the cargo and inner structure, the $G\ M$ height would be wrong by less than 2 inches and the period by about six seconds.

In applying the "equivalent figures" in Table II., the naval architect should take care to compare the values of their radii of gyration with the corresponding ones obtained from actual vessels, wherever such are available, and thus check his estimates, in particular of the radii of gyration for different conditions as regards machinery, fuel, cargo and ballast, and should, if necessary, introduce coefficients applying specially to his own designs.

The uses of the period obtained for a vessel are twofold. In the first place, it gives indication of the length of wave and force of wind at which synchronous rolling may be expected to occur, and in the second it may be an instrument in the hand of the captain for easily ascertaining by experiment at the beginning of a voyage whether his vessel is so loaded as to have a suitable degree of stability. The experiment is the one, probably familiar to him, of making his vessel roll by setting men to run to and fro across her deck. If the men run, say, first to starboard, the vessel will make an inclination in the same direction. As soon as she lifts to roll back the men must run over to port. There they must await the lift again to run back to starboard. An amplitude of rolling large enough to be measured may be obtained by a few well-timed runs made by comparatively few men. The number of seconds in which she makes, say, ten rolls may then be noted and divided by ten for the period of a single roll. This experiment is of importance to the captain as a measure of the stability of his vessel when loaded with a cargo similar to one that he has carried before. He may indeed be informed on taking over his vessel that a certain period should not be exceeded, but in the course of a voyage or two his own observation will teach him what the period indicates. If he has sailed with a much shorter period than the one given, he will know that his ship was undesirably stiff; if he has had a very long period he will know that she was tender. In some cases he may be able to correct the calculated period and substitute a more suitable one obtained by observation; in any case he has a new "foot-rule" by which to measure initial stability for himself.

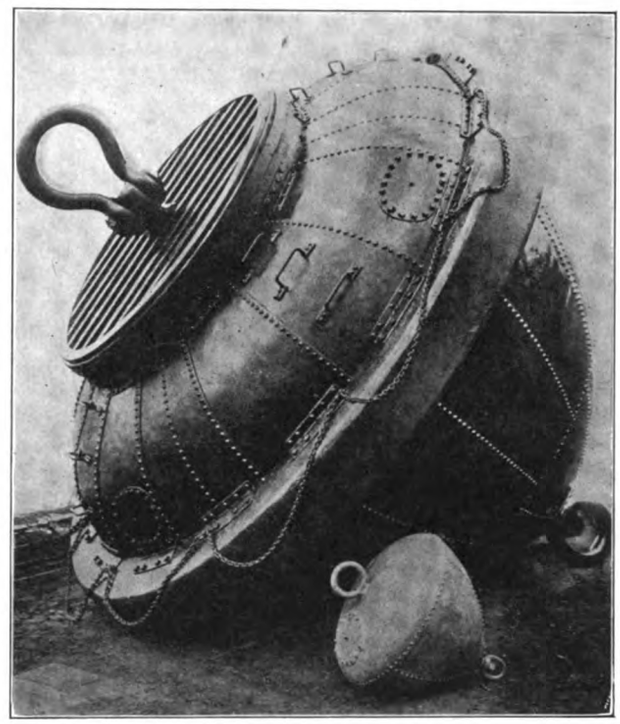
The period of a vessel with principal dimensions of 1,000 × 100 × 70 feet, a $G\ M$ height of 1 foot and a (radius of gyration)^2 of 1,500, might be about 22 seconds; if the $G\ M$ height were only 9 inches the period would be 25 seconds. Now the critical wave, the half period of which would be 22 seconds, has a length of 9,920 feet, and that for a half period of 25 seconds 12,800 feet, and such waves would seldom or never be encountered.

One of the lessons to be learned from the foregoing is that ships of the very large dimensions and small metacentric height now given, or contemplated, cannot roll to any considerable extent, and indeed have outgrown one of the most keenly-felt disagreeable features of the sea.

Mooring Buoy for Brazilian Super-Dreadnought

BY FRANK C. PERKINS

In order to carry the exceptionally heavy moorings for the Brazilian super-dreadnought *Minas Geraes,* which is one of the largest and most heavily armored war vessels afloat, the Brazilian Naval Commission had constructed recently at the works of Brown, Lenox & Company, London, Ltd., at Millwall, a 15-ton buoy built of ⅜-inch mild steel plates. The buoy itself is 15 feet in diameter, and is divided into four watertight compartments. Through the center passes a forged iron mooring bar designed to withstand a breaking-off strain of 185 tons. This has a fixed shackle, made from 6-inch diameter iron at the top and a 5¾-inch diameter swivel at the bottom. There is attached to the crown plate a wooden platform, 8 feet 6 inches diameter, to enable the men to stand with safety while making fast or letting go



Buoy for Mooring a Super-Dreadnought

the ship's cable. At the line of flotation the buoy is provided with an elm fender, 15 inches thick and 18 inches deep, to take the impact in the event of collision. With the mooring bar, the buoy weighs 15 tons, and is capable of carrying besides its own weight a load of 7½ tons when one of the watertight compartments is filled with water.

Launch of the Frank H. Buck.—The oil tank steamer, *Frank H. Buck,* building at the Union Iron Works, San Francisco, for the Associated Oil Company, was launched March 11. She is the first longitudinally-framed vessel built on the Pacific coast.

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McAndrew's Floating School

BY CAPT. C. A. McALLISTER*

"Why can't we get some of the old examination papers?" observed Nelson.

"Just try it for yourself and see," said McAndrew. "In the first place they are not published, so it is not necessary to give any other reasons.

"I have, however, put down in my notebook a number of the questions that were asked me on my different examinations, and I will give you the benefit of some of those I have had, and also of some of those I have obtained from other engineers. They are as follows:

QUESTIONS AND ANSWERS FROM MARINE ENGINEERS' EXAMINATION PAPERS

Q. What is the advantage of a triple-expansion engine over a compound; how is the power divided; how can you tell when the power is equally divided?

A. Greater economy, due to a greater degree of expansion of the steam; the power should be divided as nearly equally as possible between the three cylinders; the only way to ascertain whether the division is equal or not is to take a set of cards from each cylinder and calculate the horsepower which each develops.

Q. What are the principal types of condensers?

A. Jet and surface.

Q. What are the necessary appliances for operating a surface condenser?

A. The circulating pumps for forcing the cooling water through the tubes, and the air pump for pumping out the condensed water and the vapor from the interior of the condenser.

Q. How would you ascertain if a condenser was leaking salt water?

A. By taking off the water chest at each end and filling the condenser with fresh water. If any water runs out through the ends of the tubes there are leaks in the tubes, which, when the condenser is in operation, would admit salt water to the condenser.

Q. How many sets of valves are there in an air pump; which set could be dispensed with and the pump continue to work?

A. The valves are known as foot valves, bucket valves and discharge valves. The pump could run without foot valves, but it works better with them.

Q. What is a vacuum?

A. A vacuum means absence of air.

Q. What is steam?

A. Steam is a thin, invisible, elastic vapor formed by the application of heat to water.

Q. Is it possible to get a perfect vacuum?

A. It is not.

Q. If a vacuum gage shows 24 inches, how many pounds pressure does that indicate?

A. About 12 pounds.

Q. Suppose the steam gage shows 60 pounds and the vacuum gage 24 inches, what would be the pressure in pounds per square inch on the piston?

A. One-half of 24 inches means a pressure of 12 pounds, so the pressure per square inch on the piston would be $60 + 12 = 72$ pounds.

Q. What is the duty of a condenser?

A. A condenser serves the purpose of condensing or turning the exhaust steam back into its original state as water; in this operation a vacuum is formed which increases the power of the engine by carrying out the expansion of the steam to nearly its limit.

Q. How does a leaky condenser affect a boiler?

A. It allows salt water to be fed to the boiler, and if the leak is extensive it will cause too great a quantity of water to accumulate in the boiler, so that the boiler will have to be blown down at intervals.

Q. Describe the course of steam from the boiler to a triple-expansion engine, naming the valves and pipes, etc., it passes through until in the form of water it reaches the feed tank?

A. The steam after being formed in the boiler first passes through the dry-pipe, the object of which is to keep the water out of the steam. It then passes through the main stop valve on the boiler into the main steam pipe. In the main steam pipe is sometimes fitted a separator which removes the water from the steam. Passing through the throttle valve it enters the high-pressure steam chest, thence through the high-pressure valve into the high-pressure cylinder; after a certain degree of expansion in that cylinder it is exhausted into the first receiver, and passing through the intermediate valve it enters the intermediate cylinder, where another degree of expansion ensues. It is exhausted from the intermediate cylinder into the second receiver, and thence through the low-pressure valve into the low-pressure cylinder, where it is expanded to its final stage and then is exhausted into the condenser. There it is transformed into water by coming in contact with the surface of the cold tubes. This water is pumped out of the bottom of the condenser by means of the air pump, and is discharged into the feed tank, whence it is again pumped into the boilers by means of the feed pump.

Q. Where should the throw of the eccentric be placed in relation to the crank of a slide valve engine?

A. It should be set ahead of the crank where the steam is taken on the outside of the valve.

Q. How would you set an eccentric on a new shaft to have the valve properly set?

A. Ninety degrees ahead of the crank, plus the amount of the lap, plus the amount of the lead. Before setting the eccentric you should lock it with a set screw, and then by turning the engine around one revolution see that the lead is correct for both ends. After it is found to be in the correct position then mark and cut the keyway in the shaft.

Q. What is meant by lap?

A. The amount a slide valve overlaps the steam port, when it is in mid-position, if it is on the steam side. On the exhaust side it is the amount it overlaps the exhaust side. The former is used for regulating the cut-off and the latter to provide compression at each end of the stroke.

Q. What is meant by lead?

A. By lead is meant the amount the valve is open when the piston is at the end of its stroke. Lead is given to admit steam before the piston reaches the end of the stroke, and to start it off promptly on the new stroke.

Q. Can steam be cut off equally in the two ends of a cylinder when using a lap valve?

A. No, it cannot, for the reason that the crank is not horizontal when the piston is at half stroke, but a little above the center, due to the angularity of the connecting rod. When the crank is horizontal the piston is a little below the center of its stroke, therefore the steam follows further on the top.

* Engineer-in-Chief, United States Revenue Cutter Service.

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Q. Is the lead increased or decreased by shifting the link to mid-position?

A. If you have "open" rods the lead will increase as we run in the links, and we shorten the point of cut-off. If the rods are crossed the opposite is the case.

Q. What are the practical limits of cutting off with a slide valve?

A. It is not practicable to cut off very short with a lap valve, on account of the excessive lap necessary and the increased travel of the valve. Generally speaking, it is inadvisable to cut off at less than ⅝ the stroke, nor more than ⅞.

Q. What is the difference in the throw of an eccentric of a double-ported valve from that necessary for a single-ported valve?

A. Double-ported valves are used to reduce the travel of a valve by giving a double admission at each end, hence the travel is only one-half that of a single-ported valve.

Q. Find the area of opening in a boiler shell for a duplex safety valve, each valve being 3½ inches diameter.

A. $3.5 \times 3.5 = 12.25$, this multiplied by $.7854 = 9.62$ as the area of one valve; $9.62 \times 2 = 19.24$ as the area of the hole in the boiler. The diameter corresponding to that area is practically 5 inches.

Q. What is meant by foaming or priming? How do you explain the cause?

A. "Foaming" is the violent boiling or ebullition of the water in the boiler, the water level rises and falls rapidly, and water gets mixed with the steam and is carried to the engine; this latter action is known as "priming." Foaming is liable to occur when the boiler is dirty; when the boiler is forced to a great extent; when changing from salt to fresh feed; when too much soda is used in the boiler, or if the boiler does not have sufficient steam space.

Q. How would you check "foaming"?

A. Slow down the engine; put on a strong feed; pump and blow if necessary.

Q. What precautions are necessary when the boiler is priming?

A. Open all cylinder and valve chest drains, and if necessary slow down the engine.

Q. What are the bad effects of oil or grease getting into the boilers?

A. The oil forms a scum on the surface of the water in the boiler, and gradually collects together with particles of salt scales, sulphate of lime, etc., and will finally settle on the tubes or on the furnace crowns. Being a very poor conductor of heat it is liable to cause the metal to become overheated, with consequent collapse or bulging of the furnaces. The oil will also become decomposed, form acids and expedite electrolytic action, with its consequent pitting of the steel plates and tubes.

Q. What density would you carry the water in the boiler, using a high-pressure of steam, such as 180 pounds?

A. With steam at that pressure allow the density to rise as high as 4 or 4½ thirty-seconds before blowing, as with high temperature if we keep blowing to hold the density low, we increase the scale as the calcium sulphate in the sea water deposits at the comparatively low temperature of 290 degrees F.

Q. How would you determine the density of boiler water if the salinometer was out of order?

A. By means of noting the boiling point. Fresh water boils at 212 degrees F. under atmospheric pressure only. Ordinary sea water boils at 213.2 degrees F. At a density of 2 thirty-seconds it boils at 214.2 degrees F., and so on.

Q. How high should the water be carried over the tops of combustion chambers?

A. Not less than 6 inches.

Q. Describe a fusible plug. Where are they placed in a boiler? and for what purpose? What materials are used in their construction?

A. A fusible plug is usually made of brass, filled with Banca tin. They are to relieve the pressure in case of low water in the boiler, the theory being that the tin will melt out when there is no water over it, and allow the steam to blow through the hole thus formed. In boilers having combustion chambers they must be placed in the top, or the highest heating surface. In flue boilers one must be placed in each flue and one in the shell of the boiler from the inside just below the fire line, and not less than 4 feet from the forward end of the boiler.

Q. Where would you use a soft patch on a boiler, and how should it be applied?

A. A soft patch should be used over a weak spot on the boiler, or over a part of a joint where the rivets are corroded away and leaking. It should never be used where it will come in contact with the fire or flames. It is usual to make them of 3/16-inch or ¼-inch plate, and of a size sufficient to overlap all portions of the weak spot to be patched. A templet of lead should be made for the patch. The patch itself should be made to correspond to the templet; it should be lipped around its edges, so as to hold the putty of red lead and iron filings. Each bolt should be fitted with washers and grommets of asbestos thread rubbed down with white lead. Bake the patch with heated irons and set up as tightly on the bolts as possible.

Q. Where on a boiler would you use a hard patch, and how should it be applied?

A. A hard patch is used for a permanent job, and can be fitted over a hole or defective part of the boiler, even if it does come in contact with the fire. The defective part should be cut out, a templet made large enough to allow for a riveted joint all around the hole. The holes should be drilled from the templet, and when all is ready drive the rivets and calk the edges all around the same as in regular boiler construction.

Q. Upon what does the strength of a cylindrical boiler depend?

A. Upon the thicknes of the shell.

Q. Why are two safety valves used instead of one?

A. The combined area of the two valves must be equal to the area of one valve, as required by the rules of the Steamboat Inspection Service. When two valves are used there is less likelihood of both getting out of order than would be the case if only one is used.

Q. What should be the angle of the seat of safety valves?

A. The seats should have an angle of inclination of 45 degrees to the center line of their axes.

Q. What determines the size of safety valves of different kinds?

A. Lever safety valves must have an area of not less than 1 square inch to 2 square feet of the grate surface. Spring loaded safety valves must have an area of not less than 1 square inch for each 3 square feet of grate surface, except for watertube boilers carrying a steam pressure exceeding 175 pounds per square inch, when they are required to have an area of not less than 1 square inch for each 6 square feet of grate surface.

Q. Name all the valves on a boiler, stating the most important one and where it is placed.

A. The valves on a marine boiler are the safety valve, main stop valve, auxiliary stop valve, main feed check valve, auxiliary feed check valve, surface blow valve, bottom blow valve, drain valve and sometimes a sentinel valve.

The most important one is the safety valve, which is placed on the shell at the highest part of the boiler.

Q. What would be the result if both feed valves were shut on a boiler and the engine was in motion at full speed?

A. The water in the boiler would be gradually used up, and if not replenished the boiler would explode.

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Q. Does the water in the glass always show the true level in the boiler?

A. No, it does not. Occasionally the pipes leading to the gage glass may become choked up with hardened oil, or the valves may not be opened. These should be frequently tried to see that they are kept open.

Q. A ship has six double-ended boilers with six furnaces, each of which is 6 feet 6 inches long by 3 feet 3 inches in diameter, and when the ship is making 15 knots there is 15 pounds of coal burned per square foot of grate area per hour. How many tons of coal would be required for a voyage of 3,000 miles, and how many tons would be burned each day?

A. As each furnace is 6½ feet long and 3¼ feet in diameter, there would be 6½ × 3¼ = 21⅛ square feet in each furnace; 21⅛ × 6 = 126¾ square feet of grate surface in each boiler; 126¾ × 6 = 760½ square feet of grate surface in all the boilers; 760½ × 15 = 11,407½ pounds, or 5.09 tons of coal burned per hour; 3,000 ÷ 15 = 200 hours' time to make the voyage of 3,000 miles; 5.09 × 200 = 1,018 tons to make the voyage of 3,000 miles; 5.09 × 24 = 122.16 tons burned each day.

Q. If you were in charge of a modern triple-expansion engine, and the intermediate connecting rod broke beyond repair, what would you do?

A. Disconnect the rod at both ends; take out the intermediate valve, so as to allow the steam to pass from the high-pressure exhaust direct to the low-pressure valve chest and proceed on the voyage, using only the high and low-pressure cylinders.

Q. How long would you run a boiler if you had used only fresh water as feed before cleaning it?

A. About 700 steaming hours with the main engine in use would be about the safe limit before opening the boiler to clean it, as it will be found at the end of that time that the zincs will need renewing.

Q. If the high-pressure valve stem broke beyond repair what would you do?

A. Take out the high-pressure valve and let the live steam from the boilers blow directly through to the intermediate valve chest, and run the engine compound with the intermediate and low-pressure cylinders.

Q. How many gallons of water is pumped per hour by a single-acting plunger pump, whose diameter is 6 inches, stroke 10 inches, and making 60 strokes per minute?

A. The area corresponding to a diameter of 6 inches is 28.27 square inches. This is found by multiplying 6 × 6 = 36 × .7854 = 28.27 square inches. Now 28.27 × 10 inches = 282.7 cubic inches per stroke; 282.7 × 60 = 16,962 cubic inches per hour; 16,962 ÷ 231 (number of cubic inches per gallon) = 73.4 gallons per minute; 73.4 × 60 = 4,404 gallons per hour.

Q. What are the principal things to look after upon taking charge of a watch?

A. See first if there is a half a glass of water in each boiler, that the fires are clean, that the ashes have been blown out, that some coal is out on the plates, that no bearings are running warm, that the feed pump is working well, and that a good vacuum is being carried.

Q. What height must a safety valve be raised or lifted to allow a free escape of steam equal to the area of the valve?

A. One-fourth the diameter; thus with a 4-inch safety valve it should be lifted 1 inch.

Q. Why are counterbores put into each end of a cylinder?

A. To allow the piston to run over the edge at each end of the stroke, so that it will not wear shoulders in the bore of the cylinder.

Q. A cylinder is 30 inches diameter, the steam pressure is 125 pounds, and 30 bolts hold the cylinder cover in place. What is the stress on each bolt?

A. The area corresponding to 30 inches diameter is 30 × 30 × .7854 = 706.86 square inches, 706.86 × 125 = 88,357.5 pounds total stress on the cylinder cover; 88,357.5 ÷ 30 = 2,945.25 pounds stress on each bolt.

Q. How should the valves be connected to a boiler?

A. They should always be bolted to the shell, never riveted or screwed.

Q. How would you find out the distance the piston and shaft had worked down?

A. It is customary to mark on the cross-head slipper and cross-head guides the position of the piston at the top of the stroke. If it has worked down from the original position the amount will be the difference between the marks on the guide and the slipper. A tram is usually furnished with every engine showing the position of the top of the crankshaft, relative to the facing on the top of the bed-plate under the bearing caps. If the shaft is worn down, the distance can be ascertained by fitting the tram in place on the bed-plate facing and measuring the space between the tram and the top of the crankshaft.

Q. What are the principal things to look after before starting fires?

A. See that there is sufficient water in the boiler, that all valves work freely, particularly the feed check valves; that the air cock or the top gage cock is left open, to allow the air to escape, and that all man and hand-holes are set up tightly.

Q. Before turning the engine over what precautions are necessary for the engine and vessel?

A. Inform the deck officers so that they can see that sufficient lines are out to hold the vessel to the wharf, and that everything is clear around the propellers. In the engine-room see that the turning gear is disconnected; that the water service is turned on; that all bearings have been oiled; that there is nothing in the crank-pits, and that all hands are clear of the engine.

Q. When the pumps are connected to the engine what would you look after before starting?

A. See that the air pump is not filled with water, and that all valves on the discharge side of the feed pumps or bilge pumps are open.

Q. What are the causes of feed pumps working poorly?

A. Generally, bad management. Either the pumps are not getting the water from the hot well regularly or the check valves on the boilers may be closed. Possibly the valves in the water end of the pump are out of order.

"The foregoing questions which I have quoted cover about the usual ground that is embodied in the examination given by the inspectors for your first papers. I do not mean to imply that you will get any of these particular questions when you go up for your tickets, but if you understand the principles upon which each of them is worked you ought to be able to pass any examination which they give you.

"This will conclude my course of lectures to you. I know I have not covered every subject in marine engineering, as many volumes have been written on the subject. I have endeavored to give you a good general idea of what you will have to know to be successful. You must not let up in your studies, as no man can keep up to date unless he is constantly studying. By that I do not mean that you should devote all your spare time to books, but at your ages you should give at least one hour a day of your time off watch to studying some of the many subjects connected with your business."

"Chief, can you recommend us some good books to get?" queried Pierce.

"Oh! yes, indeed I can; there are lots of good books which you can buy which will be very helpful to you. For example, there are several correspondence schools wherein for a small sum each month you can not only receive their courses of instruction, but you will get their text books into the bargain.

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As a rule these books are excellently gotten up and will be of great value to you.

"For a good all-around text book on marine engineering it is doubtful if you can find any better than that written by Prof. W. F. Durand. He was once a sea-going engineer himself before he settled down in a college, so he knows both the practical and the theoretical sides of the business. Many of the best books on marine engineering are by English authors, as the whole world must admit that Great Britain has produced some of the ablest of engineers, particularly those in the marine branch. When you get further along in your business you should each buy yourself a copy of 'Reed's Engineer's Handbook.' All these books are, of course, very useful to you, but you can each write your own book on the subject."

"Gee! we're no highbrows," blurted out O'Rourke.

"You don't have to be to write the kind of book I'm going to tell you about.

"You should each get a good-sized blank book, made of serviceable paper for writing with ink and well bound. Whenever you see anything of interest in a text book or in any of the engineering papers you may read, copy it down in this notebook. If some older engineer tells you of a good method of making any particular kind of repairs, or gives you any information that you think will be valuable in the future, make copious notes of them in your book. As you grow older you will find that such a note book will become invaluable for reference, and it will increase in value to you every year that it is kept up. When you take your first examination write down all the questions you can remember, and work them out in your notebook. Even if they are not of much value to you after you have attained your license, they may help some young fellow who is coming after you later on.

"When these lectures which I have given you are published in book form, I am going to ask the publishers if they will print in the back of the book a lot of tables and useful information which every marine engineer should have handy. These will include tables of areas of circles, strength of materials, temperature of steam at different pressures, weights of different kinds of substances with which marine engineers have to deal, etc. I will also ask them to bind with the book a few blank pages, upon which you can write down any other bits of information you may run across which will be of value to you in your business.

"This will be my last regular talk with you boys as a class in the 'Floating School,' but I will be only too glad to help you with any of your problems whenever I have the opportunity. As it is about time for you to go on watch you had better turn to. I'll keep my eye on each one of you and see that you get a chance as soon as you can get your tickets."

"Chief," said Jim Pierce, who had been appointed spokesman of the class, "I cannot tell you how much all of us appreciate your kindness to us. Every one of us has benefited a great deal by the instruction you have given us, and we hope to show you by what we accomplish that your labors with us have not been lost. We want to ask you one parting favor before the 'Floating School' is broken up, and that is if you will do us the honor of going to dinner with your class when we reach New York."

"That's easy," laughingly replied McAndrew, "of course I will."

About ten days afterward the *Tuscarora* arrived in New York. The boys had talked over the dinner they were to have on every occasion when they came together.

O'Rourke insisted that it must be a "swell dinner," and that "no ordinary West Street restaurant chuck" would go. To this all very readily agreed, and it was decided that they would "blow themselves in a bang-up Broadway joint," as O'Rourke expressed it.

Promptly at the appointed hour the four sea toilers, arrayed in their best for the occasion, and accompanied by Chief McAndrew, sat down at a fashionable Broadway restaurant not far from Forty-second street. They were not, of course, togged out in evening clothes, as were most of the other men diners, but their clean-shaven faces, stalwart forms and generally spick appearance made them a very presentable group. O'Rourke had elected himself as master of ceremonies, but he was somewhat taken aback when the polite head waiter handed him several bills of fare, and asked if the party would be served à la carte or table d'hote. After getting his breath he replied:

"Aw, cut out that frog-eater's chatter and give us the best chow you've got in the joint."

McAndrew came to the waiter's rescue, and told him to serve the dinners table d'hote, afterwards explaining to his hosts that that meant they would have to pay only $1.50 each for the dinner, and that they would get a very good meal for less than it would cost them on the other plan.

What the boys lacked in style they made up in robust appetites, so as each course was served it was quickly disposed of with a noticeable lack of the usual picking and faultfinding indulged in by the habitues of such places. True, there was somewhat of a mix-up in the use of a multiplicity of knives, forks and spoons placed at each plate, but each was made to serve a good purpose, even if Schmidt did try to eat his fish course with a combined fork and spoon usually reserved for the ice cream.

The menu was printed in French, which caused much speculation as to the composition of the next course, and some grave doubts as to the course under consideration at the time.

O'Rourke had looked forward with great expectation to the viand described as "pommes de terre au naturel," and could not refrain from venting his disappointment when they were served, by shouting out, "Gee! they're nothing but plain old boiled spuds with some grass on them."

When the "café demi-tasse" was served at the conclusion of the meal, he nearly precipitated a small riot by demanding in loud tones that he be given "a man's size cup of coffee."

However, the influence of the good dinner soon calmed his ruffled temper, and when the real Havanas, not Savannahs, as O'Rourke announced he had been accustomed to smoking, were lighted, all was serene at the table.

Drawing a small package from his pocket, Pierce, in a few well-chosen and heartfelt words, presented it to McAndrew. Upon opening the package, McAndrew found, to his complete surprise, that it contained a handsome gold watch and chain. Upon the back of the watch was neatly engraved the following:

"To Chief Engineer James Donald McAndrew, with the highest esteem and gratitude of his pupils in the 'Floating School.'"

Quite overcome with this evidence of his pupils' appreciation of his efforts, McAndrew cleared his throat and said:

"Boys, what I have done for you was not with the hope of getting any such handsome reward as this, but from the interest which I take in young men who are anxious to advance themselves in their life work. Each one of you has the making of a good engineer in you, and I wish for you all every success in your efforts to advance. If my instructions serve to help you in accomplishing the first steps in your advancement I shall feel more than repaid. When you get further along, and want to try for higher grades of licenses, I shall, if you desire, and if conditions are such that we can all be together again, be only too glad to try to aid you in the same manner that I have attempted to do with the 'Floating School.'"

"We'll have to call it the 'Floating High School,'" responded O'Rourke, who was bound to have the last word.

THE END

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Cutting Up the Wreck of a Steel Ship wfth the Oxy-Acetylene Torch

The tangled wreckage of the 1,800-ton steel freight steamer *Alum Chine*, which was destroyed by a dynamite explosion in the lower harbor of Baltimore on March 7, 1913, has recently been reduced to steel mill scrap with the aid of the oxy-acetylene cutting torch. This steamer was destroyed by an explosion of 300 tons of dynamite in its hold while loading a cargo for Panama. The violence of the explosion was so great that the entire forward part of the ship was blown away, the deck and upper works being reduced to bits and scattered over the harbor and adjacent shores for a radius of several

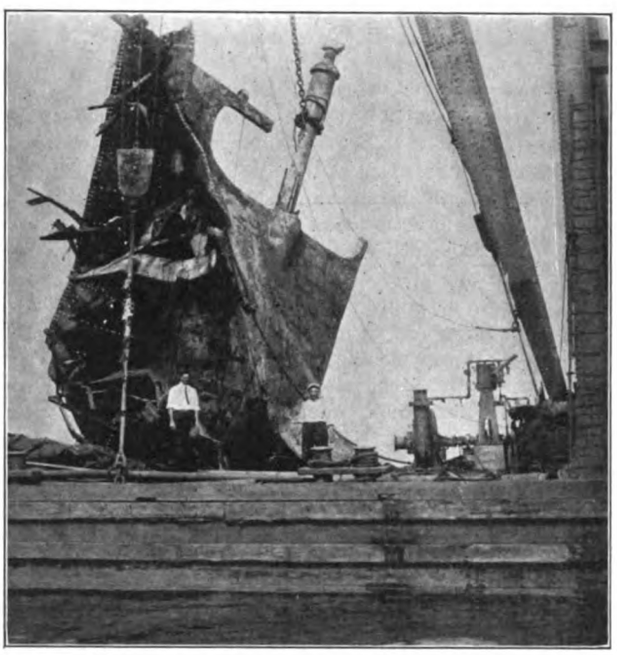

Fig. 1.—Hoisting Stern of Wrecked Vessel from Salvage Scow

miles, while the major part of the hull was thrown to the bottom in 33 feet of water. Pieces of steel 3 to 5 feet long were found at distances 2 to 3 miles from the wreck.

A survey of the site showed that the after part of the hull, containing several hundred tons of steel, lay just outside the channel, covered by about 13 feet clear depth of water. The entire upper works, boilers and engines were gone, and the steel beams and plates were badly bent and twisted. It was necessary to remove the wreck in order to protect navigation, and a contract for this was let during the past summer to the Merritt & Chapman Derrick & Wrecking Company, of New York. An 80-ton steel floating derrick was detailed to the work. Divers were sent down to lay strings of dynamite, which were exploded under water so as to cut the hull into pieces of a size that could be handled by the derrick. The sections were then lifted onto a scow and towed to the dock and yard of the Southern Iron & Metal Company, of Baltimore, a concern which had purchased the steel from the wrecking contractors for disposal as steel furnace scrap. At the dock the floating derrick laid down the 25- to 40-ton pieces of the hull in a huge pile, as shown in the accompanying views.

Each large piece was a shapeless mass, with the plates, beams and members bent and crumpled. Rivets could not be removed to good advantage, since in many cases the flanges of angles or pieces of plate were bent over flat against them, preventing access to their heads. Most of the skin plating of the ship was 5/8-inch steel, running to greater thicknesses in the sheer, bilge and garboard strakes. The frames and stringers were deep, built-up sections of plate and angles. The condition of the steel was such that the expense of ordinary hand cutting would have been prohibitive, and the wreckage would have been a total loss had the oxy-acetylene process not been available.

A Milburn oxy-acetylene plant, mounted on a truck for portability, was supplied by The Alexander Milburn Company, of Baltimore. One torch operator was employed, long lines of gas hose being provided to allow sufficient freedom of movement about the wreckage, in order to attack it from points of greatest convenience. As fast as the pieces of steel of suitable size for handling were cut out by the torch they were loaded on wagons and then to freight cars for transportation to the mills.

It was impossible to establish a definite routine of dismantling the wreckage, both on account of the condition of the steel work and on account of inaccessibility. The work was simply started from the top or one side of the pile, and carried as far as convenient from that point, then resumed from some other point.

Owing to the irregularity of the work very little data were obtainable as to the rate of progress and other details. This was also complicated by the fact that the work was carried on only periodically, the operator being otherwise employed during a considerable part of his time.

Obituary

GEORGE WESTINGHOUSE, famous the world over as an inventor, engineer and manufacturer, died of heart disease in New York City, March 12, at the age of 67. Mr. Westinghouse was born at Central Bridge, Scoharie County, New York, Oct. 6, 1846. His first experience in mechanics was gained at the Schenectady Agricultural Works, which was established by his father in Schenectady, N. Y., in 1856. In 1863, when only 17 years old, Mr. Westinghouse enlisted in the army, and served in the infantry and cavalry, until in 1864 he was appointed third assistant engineer, United States navy. At the close of the war, he resigned from the navy and entered Union College, which he left at the end of the sophomore year to take up his career as an engineer. In 1865, he invented a device for replacing railway cars upon the track, which was manufactured at Troy, N. Y. Soon after that, what is generally recognized as his greatest invention, the air brake, was brought out. The first patent for the air brake was issued April 13, 1869, the Westinghouse Air Brake Company was formed July 20 and a factory was established in Pittsburg in 1870. At first Mr. Westinghouse had difficulty in introducing the air brake, but he was continually perfecting the device, until in 1886 he brought out the quick action brake, with its triple valve. The introduction of switch and signal systems operated by compressed air, controlled by electricity, soon followed the introduction of the air brake, and in 1885 Mr. Westinghouse began to develop the alternating current system, which has meant so much to the industrial, manufacturing and commercial world in the last generation. It was Mr. Westinghouse who introduced the Parsons turbine in the United States. He has long been interested in the question of ship propulsion and has brought out, in collaboration with the late Rear Admiral Geo. N. Melville and John H. MacAlpine, the highly ingenious reduction gear for turbine-driven ships, which is now being applied to both naval and merchant vessels. Mr. Westinghouse received decorations from the French Republic, the King of Italy, and the King of Belgium. He was the second person to receive the John Fritz medal, and in 1912 he was awarded the Edison medal by the American Institute of Electrical Engineers. Last December he received the German Grashof medal.

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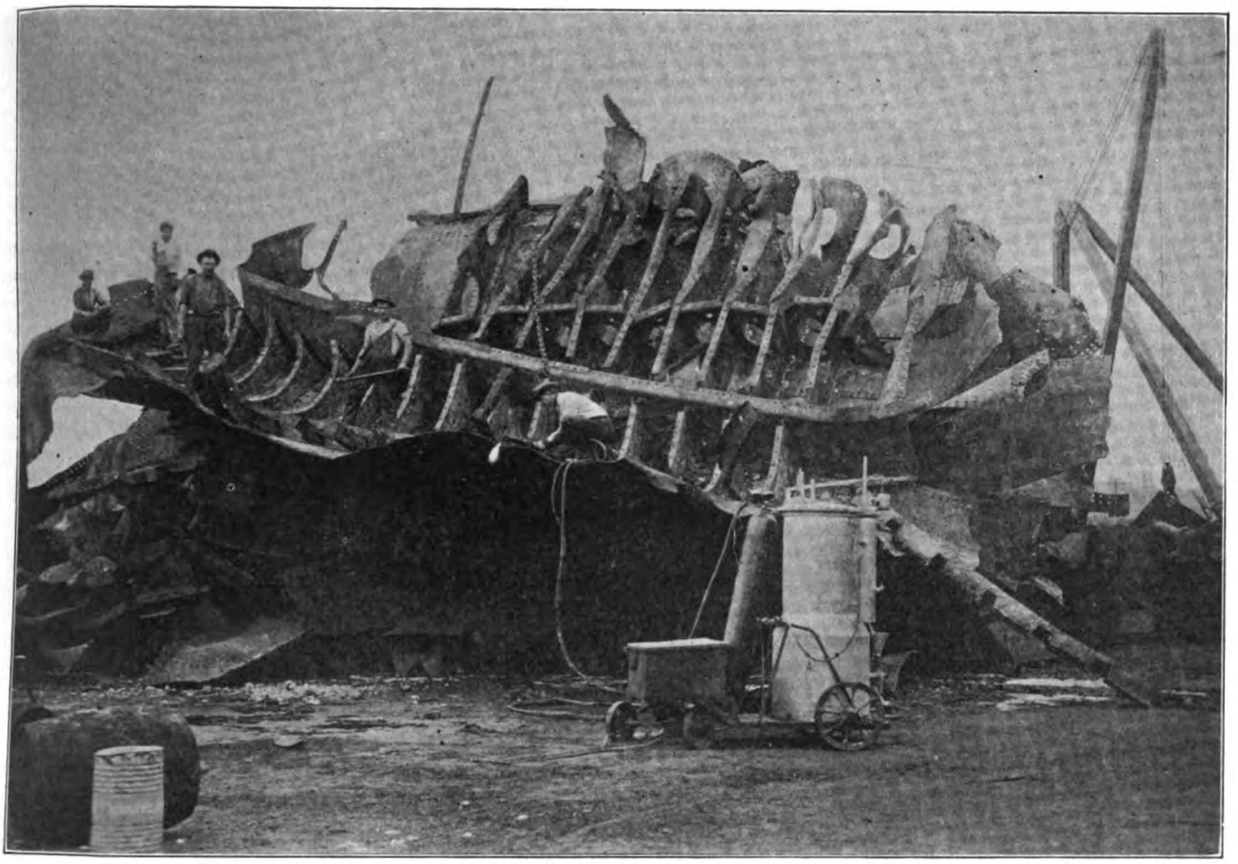

Fig. 2.—Torch Operator Cutting Apart Bottom Plating of Wrecked Vessel

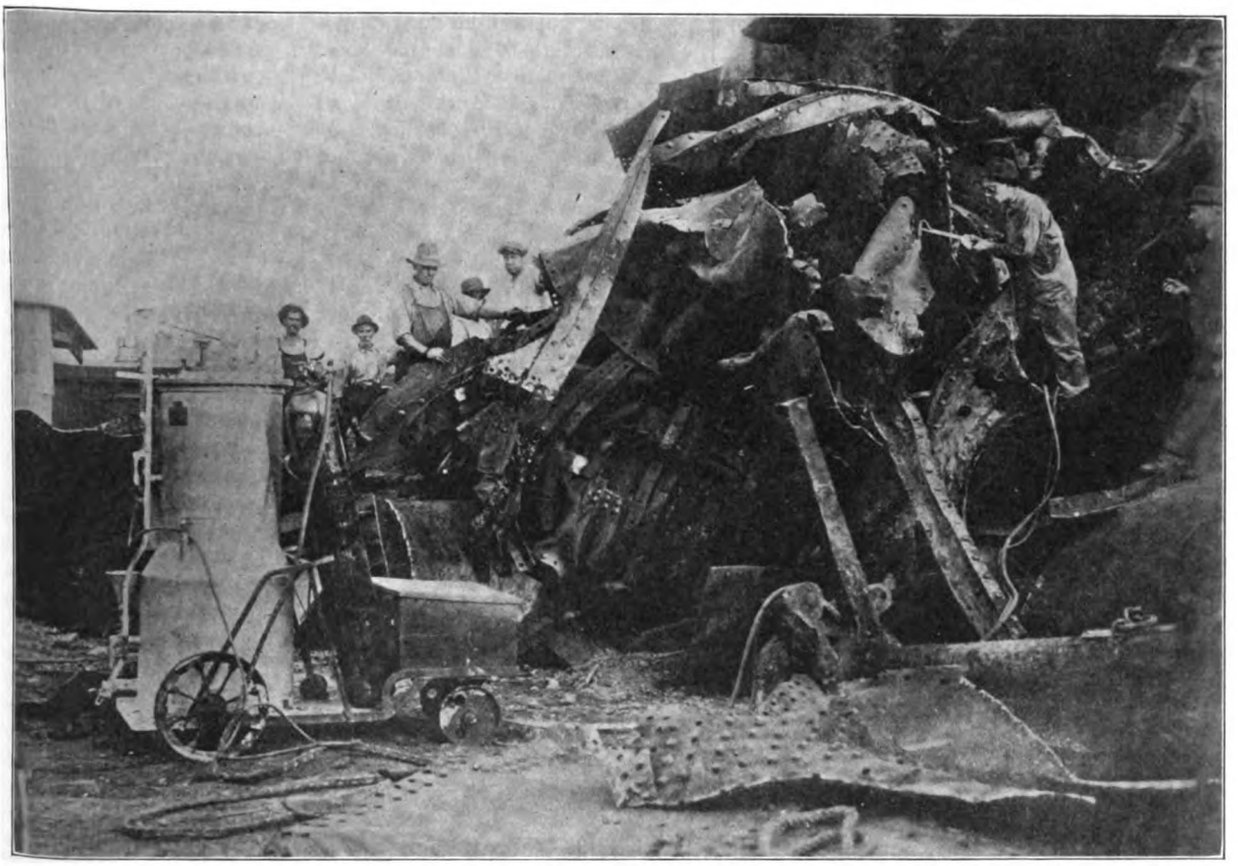

Fig. 3.—Cutting Bent and Twisted Plates with Oxy-Acetylene Flame

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The Design of Merchant Ship Forms

A Systematic Method for Correlating the Various Factors in Determining the Best Form for a Merchant Ship

BY PETER DOIG

Within late years there has been published a considerable amount of experimental data on the best forms for ships of the usual proportions, fullnesses and speeds current in merchant vessel practice, but, so far as the writer is aware, there has been made public no attempt to standardize these into a systematic method enabling the naval architect to fix on shapes which will ensure easy propulsion and be consistent with the requirements of the other elements in design. Hitherto, for those without the aid of model experiment, the usual procedure has consisted in following the "lines" of some previous satisfactory ship.

While obviously the best under the circumstances, this method has at least one defect, which may be responsible

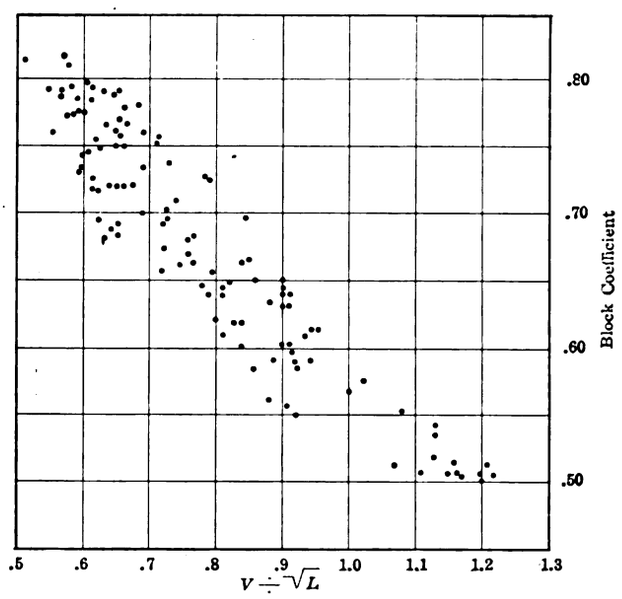

Fig. 1

for some disappointment in performance. For it may happen that the type vessel followed owes its relative success to a good propulsive result rather than to an easily propelled hull. Hence, if the new ship should happen to have a combination of power, revolutions of screw and speed less favorable to high-propeller efficiency, the former good propulsive performance will not be repeated and the all-around result as an economically-driven hull will not be so satisfactory. This is more likely than ever to happen at the present time, which is witnessing frequent transitions from one form of motor to another, with accompanying differences principally in number of screws and their revolutions, and consequent change in propeller efficiency. The added importance of some guide to good forms is thus evident.

The model towing investigations of Froude, Taylor and Sadler have put before the shipbuilder a body of information from which a good shape of hull for any normal design of ship can be obtained with some little care. One of the first points which strike the student of these results is that there is no quality of "form" (by which is meant the nature of the sections of the ship's underwater body) which is good at all speeds; or, in other words, there is no ship shape of "minimum resistance." Convexity, straightness or hollowness of sectional outline may any of them be best for a particular fullness and speed, but far from it at some other combination of these factors.

To bring the problem within reasonable dimensions it therefore appears desirable at the outset to connect the two factors of fullness of form and speed at which a given fullness is usually driven in good practice. In Fig. 1 have been plotted the "block coefficient" (C_b) and speed-length ratios $\left(\text{speed in knots} \div \sqrt{\text{length}} \text{ or } \frac{V}{\sqrt{L}}\right)$ of a large number of merchant craft ranging in length from 250 feet to 850 feet and in speed from 10 knots to 25 knots. Almost without exception these are found in a well-marked zone, which has a breadth of from 0.15 to 0.20 expressed in speed-length ratio. The extremes of this zone may be taken to be those which practical experience has sanctioned as the economical limits for merchant vessels.

Further study of these model results shows that the virtue or reverse of any quality of form persists for a range of speed which is generally large enough to cover the range of $\frac{V}{\sqrt{L}}$ appropriate to any particular fullness in Fig. 1; and it is also to be noticed that within the usual limits of proportions in merchant craft the best shapes are not materially affected by changes in the ratios of length to breadth or draft to breadth. For normal vessels it would thus appear necessary to relate to fullness alone such qualities as may be deemed worth consideration in a standardized method of design.

The factors defining a good form are based principally on the fact enunciated in the following quotation from R. E. Froude's paper on cruiser forms (Trans. I. N. A., 1904):

"The resistance of a form is determined solely by the curve of cross-section areas, together with the extreme beam and the surface waterline of the forebody; if these are adhered to, the lines may be varied in almost any reasonable way without materially altering the resistance."

In the present treatment of the question, the curve of the ratios of cross-section area to mid area or "prismatic curve," and the shape of the load waterline, are adopted as the standards to which the method is intended to lead.

With a given set of dimensions it is evident that, if the load waterline breadth and area of transverse section at each station in the vessel's length are known, the nature of the transverse outlines is to some extent defined and an approximate form adumbrated. As these are, moreover, the most important features in determining an easily-driven shape, once proportions and fullness have been decided on, the value of a method giving them satisfactorily should be evident.

In constructing methodical curves for the sectional areas and load waterline half breadths of good forms the writer has taken into consideration the published results of Taylor ("Parallel Middle Body, Influence of Form on Resistance," etc.), Sadler ("Disposition of Displacement in Ships of Moderate and Full Forms") and Froude (various papers on "Cruiser Forms," etc.). For several fulnesses, sets of "ideal" lines were drawn adopting normal values of sheer and rise of floor, and to the average proportions of length, breadth and draft, as indicated empirically by the plotting of these ratios for the

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ships used in constructing Fig. 1. These were then adjusted to suit the other important elements of merchant ship design, such as stability, ability to maintain speed in a seaway, longitudinal disposition of volume for cargo holds, deck space at ends, etc., so far as these affect underwater shape; and final "practical" sets of lines derived which were then modified for the range of longitudinal position of center of buoyancy necessary to cover practice.

In constructing these the normal values of mid-area coefficient C_m (immersed sectional area amidships ÷ breadth multiplied by draft), and the ratio of breadth to draft, have been taken for varying prismatic coefficients as follows:

TABLE I.

C_p	C_m	*Breadth ÷ Draft*
.5	.92	3.6
.6	.94	2.7
.7	.96	2.2
.8	.98	1.9

TABLE II.

Prismatic Coefficient	Station.										
	½	1	2	3	4	5	6	7	8	9	9½
.52	.033	.117	.369	.642	.878	1.000	.916	.680	.404	.185	.084
.54	.051	.146	.399	.664	.890	1.000	.926	.711	.443	.207	.094
.56	.070	.174	.427	.687	.901	1.000	.937	.745	.484	.227	.102
.58	.089	.203	.456	.709	.911	1.000	.948	.782	.527	.245	.108
.60	.106	.230	.485	.732	.922	1.000	.959	.822	.572	.259	.111
.62	.121	.252	.514	.754	.934	1.000	.971	.862	.618	.271	.112
.64	.137	.272	.544	.778	.943	1.000	.982	.897	.666	.283	.112
.66	.152	.290	.575	.805	.955	1.000	.992	.926	.712	.300	.114
.68	.164	.310	.608	.835	.968	1.000	1.000	.950	.753	.325	.122
.70	.176	.331	.644	.868	.982	1.000	1.000	.969	.792	.358	.138
.72	.187	.352	.683	.904	.993	1.000	1.000	.982	.826	.399	.161
.74	.200	.379	.727	.931	.998	1.000	1.000	.992	.857	.451	.194
.76	.215	.415	.773	.953	1.000	1.000	1.000	.995	.881	.513	.238
.78	.232	.468	.819	.967	1.000	1.000	1.000	.997	.902	.586	.293
.80	.250	.524	.858	.978	1.000	1.000	1.000	.998	.920	.648	.347
.82	.275	.588	.892	.989	1.000	1.000	1.000	1.000	.941	.705	.406
.84	.309	.655	.921	.997	1.000	1.000	1.000	1.000	.963	.757	.466

TABLE III.

Prismatic Coefficient	Station.										
	½	1	2	3	4	5	6	7	8	9	9½
.52	.051	.146	.396	.666	.889	1.000	.909	.648	.373	.162	.072
.54	.069	.174	.426	.689	.900	1.000	.918	.679	.408	.184	.083
.56	.088	.202	.457	.713	.910	1.000	.928	.712	.446	.205	.092
.58	.106	.230	.489	.737	.923	1.000	.938	.747	.486	.224	.100
.60	.123	.255	.521	.762	.934	1.000	.948	.784	.528	.241	.106
.62	.137	.276	.555	.787	.946	1.000	.960	.821	.571	.255	.109
.64	.151	.295	.586	.812	.957	1.000	.970	.856	.615	.267	.109
.66	.165	.316	.619	.839	.968	1.000	.979	.887	.659	.282	.111
.68	.178	.338	.655	.868	.979	1.000	.988	.915	.701	.302	.117
.70	.192	.365	.693	.897	.989	1.000	.995	.938	.741	.328	.127
.72	.205	.394	.732	.925	.996	1.000	.999	.957	.778	.363	.145
.74	.222	.431	.773	.949	.999	1.000	1.000	.972	.812	.407	.171
.76	.242	.477	.813	.967	1.000	1.000	1.000	.981	.841	.459	.206
.78	.267	.534	.853	.981	1.000	1.000	1.000	.987	.868	.520	.249
.80	.294	.592	.889	.989	1.000	1.000	1.000	.992	.892	.580	.296
.82	.329	.650	.921	.995	1.000	1.000	1.000	.996	.916	.638	.347
.84	.375	.707	.949	.998	1.000	1.000	1.000	.999	.938	.692	.403

TABLE IV.

Prismatic Coefficient	Station.										
	½	1	2	3	4	5	6	7	8	9	9½
.52	.070	.175	.423	.690	.900	1.000	.901	.616	.342	.139	.060
.54	.089	.203	.456	.714	.911	1.000	.910	.648	.375	.161	.072
.56	.108	.231	.489	.740	.922	1.000	.919	.680	.410	.184	.083
.58	.125	.257	.523	.766	.934	1.000	.929	.713	.447	.205	.092
.60	.139	.280	.559	.792	.947	1.000	.939	.746	.484	.223	.099
.62	.150	.298	.594	.818	.959	1.000	.949	.780	.523	.237	.104
.64	.166	.319	.630	.847	.973	1.000	.958	.814	.563	.251	.108
.66	.179	.342	.665	.874	.983	1.000	.967	.848	.606	.264	.110
.68	.192	.368	.703	.901	.990	1.000	.976	.879	.650	.280	.110
.70	.207	.399	.743	.926	.995	1.000	.984	.907	.692	.301	.117
.72	.223	.437	.782	.946	.998	1.000	.992	.931	.731	.328	.130
.74	.243	.483	.818	.963	1.000	1.000	.998	.951	.768	.364	.149
.76	.269	.538	.852	.981	1.000	1.000	1.000	.966	.802	.405	.174
.78	.300	.599	.885	.994	1.000	1.000	1.000	.978	.834	.455	.205
.80	.336	.657	.918	.999	1.000	1.000	1.000	.986	.863	.510	.244
.82	.382	.712	.949	1.000	1.000	1.000	1.000	.991	.890	.568	.290
.84	.441	.760	.977	1.000	1.000	1.000	1.000	.994	.913	.627	.340

Tables II, III and IV are constructed to give the sectional areas in terms of midship area, at stations on every tenth of the ship's length and on intermediate half-ordinates at each end. They have been figured for positions of center of buoyancy at one percent of vessel's length forward, amidships, and one percent aft, respectively. By linear interpolation or exterpolation any intermediate or external value of prismatic coefficient and position of center of buoyancy can be worked to.

The author recommends the use of the above values of C_m where possible; but some deviation from them is practicable, although excessive rise of floor or fineness of bilge is not contemplated for use with Tables II, III and IV.

(*To be concluded.*)

The Stability of Submarines While Filling Ballast Tanks*

BY MARINESCHIFFBAUMEISTER WERNER

It is essential that both designers and builders as well as naval officers and engineers have a clear conception of the stability characteristics of submarines before attempting to build or command such craft.

For the boat in the light or emerged condition, as also when fully submerged, the problem is simple. In the former case, *i. e.*, with ballast tanks empty, the stability does not differ from that of an ordinary vessel. Submerged, *i. e.*, with the ballast tanks completely filled, the stability, or righting moment, is always equal to the product of the weight of the boat into the horizontal projection of the distance between the center of gravity and center of buoyancy. Mathematically expressed, it is: Moment of statical stability = weight of ship × distance between *C. G.* and *C. B.* × sine of the angle of inclination.

In order that this moment may not become zero, or, in other words, in order that a righting tendency may always exist, the center of gravity in the fully submerged condition must always lie below the center of buoyancy.

During the process of filling the ballast tanks the conditions are not so simple. In technical literature this case is usually passed over with the remark that the designer must take care that at the instant "stability of form" disappears during submergence, the boat has sufficient "stability due to weight." The converse of this requirement, namely, that with diminishing weight stability during emergence there must be sufficient form stability is equally true. This proposition and its converse are too general to indicate fully what takes place during the process of filling or emptying the ballast tanks. The following will therefore deal mainly with determining what constitutes "sufficient" stability, at the same time demonstrating the truth of two propositions, viz.:

1. The presence of "initial weight stability," *i. e.*, the center of gravity located below the center of buoyancy, does not necessarily ensure, during the process of flooding the ballast tanks, that the boat, in all practical longitudinal and transverse inclinations, possesses a righting tendency.

2. The presence of "initial form stability" in the upright condition does not always ensure, with absence of weight stability, during the process of flooding, a righting tendency of the boat when inclined.

The following notation will be employed:

P = weight of ship.
V = volume of displacement.
J = moment of inertia of the water plane about the center line of the ship (axis of symmetry).
J_1 = moment of inertia of the free surface of the ballast water, at any instant of flooding, about the center line of the ship.

* Translated from *Marine Rundschau* by Louis Eckert.

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M = metacenter of the ship when upright.
$M\ \Phi$ = metacenter of the ship when inclined Φ degrees.
B = center of buoyancy in the upright condition.
$B\ \Phi$ = center of buoyancy in the inclined condition.
G = center of gravity.
l = righting lever.
γ = specific gravity of the sea water.

It is well known that the metacentric height $G\ M$ of a

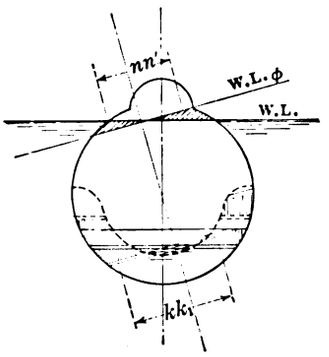

Fig. 1

floating body carrying free water in its interior is given by the equation

$$G\ M = \frac{J - J_1}{V} + B\ G;\ +\ \text{or}\ -\ B\ G,$$

according as B lies above or below G. Proposition 1 assumes $B\ G$ positive, $G\ M$ therefore remains positive so long as

$$\frac{J - J_1}{V}$$

remains positive, or in case $J_1 > J$ that $\frac{J - J_1}{V} < B\ G$.

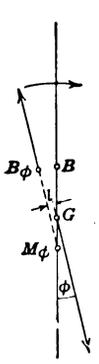

Fig. 2

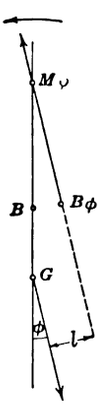

Fig. 3

During the process of flooding, the free water surface in the ballast tanks gradually increases, reaches its maximum and becomes equal to zero when the tanks are completely full. The water plane, on the contrary, decreases, and finally becomes likewise equal to zero. The free water surface, toward the end of the process of flooding, generally becomes greater than the corresponding water plane, $J - J_1$ becomes therefore negative. In case

$$B\ G < \frac{J - J_1}{V},$$

then $G\ M$ also becomes negative, *i. e.*, the boat, when inclined by outside forces such as may be produced by a seaway, unequal filling, etc., not only has no righting moment but will continue to incline until $G\ M\ \Phi$ again becomes positive. That the latter condition must always set in in modern types of submarines will be shown in the considerations that follow. Whether this occurs sooner or later depends on the form of hull.

Fig. 1 shows the cross section of an earlier form of "single-hull boat, the dotted line giving the control of the ballast tank of the later "single-hull" boats. Assume the boat in-

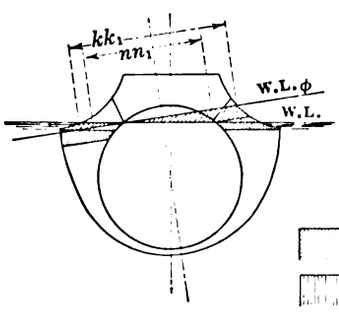

Fig. 4

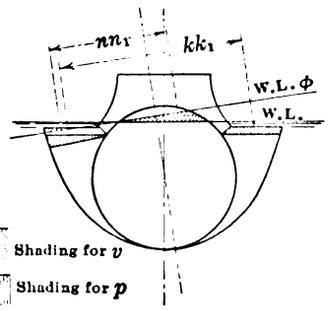

Fig. 5

clined through the angle Φ by some extraneous force; let $n\ n_1$ denote the shift of the center of gravity of the wedge v of the volume of reserve displacement; $k\ k_1$ the shift of the center of gravity of the wedge p of the free water ballast; then the resulting side shift of the center of buoyancy B from its mid position to $B\ \Phi$ is given by

$$B\ B\ \Phi = \frac{\gamma\ v \cdot n\ n_1 - p\ k\ k_1}{\gamma\ V}.$$

The proof of this may be assumed from the theory of naval architecture.

When the moment $\gamma\ v\ n\ n_1 < p\ k\ k_1$, as shown in Fig. 1, the center of buoyancy shifts away from the side toward which the ship is inclined and $B\ M\ \Phi$ becomes negative. Now as soon as $M\ \Phi$ falls below G, mathematically expressed $B\ M\ \Phi > B\ G$, an upsetting couple $P\ l$ (Fig. 2) will act, increasing the inclination until the ballast tank top causes the free surface of the ballast water to become smaller and smaller. For

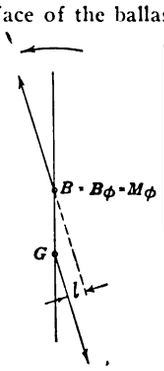

Fig. 6

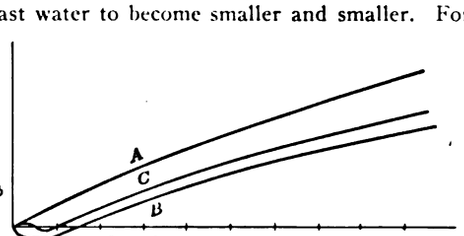

Fig. 7

the tank form indicated by the dotted line, Fig. 1 shows the condition in which the limit has already been reached beyond which the couple begins to act in the contrary direction and a righting tendency sets in, for water can now no longer shift over ($p\ k\ k_1 = o$).

When the moment $\gamma\ v\ n\ n_1 > p\ k\ k_1$, a righting couple will act (Fig. 3), since the center of buoyancy $B\ B\ \Phi$ shifts toward the side to which the boat is inclined. Figs. 4 and 5 show the cross sections of two "double-hull" boats, differing from each other only in the form of the ballast tanks. In Fig. 5 it will be noticed that, for the instant of flooding indicated, the free water surface is considerably larger than the water plane. The boat is for the time being without initial stability of form, but at the inclination Φ it has already reached the limit be-

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yond which $G\ M\ \Phi$ again becomes positive, for then the fully-immersed tank is completely filled, while with the boat of Fig. 4 this limit is reached only after greater inclination.

When $\gamma\ v\ n\ n_1 = p\ k\ k_1$ (Fig. 6), then $B\ B\ \Phi = o$ and $G\ M\ \Phi = B\ G$; *i. e.*, the boat has stability due to weight alone. If the ballast water were free to shift like bilge water, the case might arise in which, with a free surface sufficiently large and weight stability very small, the limit above mentioned would not set in, and the boat would founder.

The form of the ballast tank is therefore of great significance as regards magnitude of and variation in $G\ M\ \Phi$. The variation in the moment of statical stability $P\ l$ for any assumed condition of flooding, is most readily seen from the usual graphical representation of the righting levers of statical stability (Fig. 7). Such a curve, it must be noted, shows the variation for only one condition of flooding, being different for every other condition. For the light, or fully emerged condition, the curve will be positive throughout, the same being true of the fully submerged condition, but with the difference that in the former case the shape is that of a

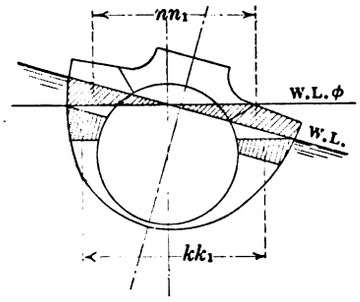

Fig. 8

modified sinoid, depending on the form of hull above water, while in the latter case it is a true (mathematical) sinoid. Curve *A*, Fig. 7, shows the variation in stability of a boat possessing a righting tendency throughout, such as is the case with any properly designed surface vessel. Curves *B* and *C* illustrate the variation in stability for the cases in which, on the one hand, there is negative initial stability, and on the other hand, though positive initial stability, yet followed by a short period of negative stability. The assumption in all cases is a positive $B\ G$. From Fig. 7 it is evident that, although $B\ G$ is positive, this does not signify that the curve of righting moments for larger inclinations is necessarily positive throughout, even with the presence of positive initial stability as shown in curve *C*.

In flooding the tanks in a seaway it may therefore happen that the boat takes a sudden lurch to the limiting angle at which the righting arms again become positive. Taking into consideration the dynamical influence of the seaway and the free surface of the ballast water, a considerable tilt beyond this limiting angle must even take place. This, however, is not attended with any danger of foundering, since beyond the limiting position quickly-increasing righting moments at once set in. Besides this, the condition of flooding is constantly changing and the free water surface diminishing, so that the limiting angle gets smaller and smaller, necessarily reaching zero when the ballast tank is completely filled.

The calculation of the arms of the righting moments for longitudinal and transverse inclinations during flooding is therefore of great importance for judging the qualities of a submarine; to know that $B\ G$ is positive is not sufficient in itself for this purpose. From the curve one sees at a glance what peculiarities one may expect during flooding, and at what point the limiting angle is reached to which the boat might eventually incline; one realizes the fact of the inability of the boat to founder. But, above all, it also shows that even mistakes in the flooding procedure, and consequent unequal filling, do not signify any immediate danger. It must again be pointed out, however, that up to now all considerations presupposed the existence of stability due to weight, *i. e.*, that the center of gravity lies below the center of buoyancy. . .

We come now to the converse of the original proposition, for which the condition was imposed that there be absence of weight stability, *i. e.*, $B\ G = o$, or negative, and $B\ M$ always positive, therefore $J > J_1$ for the mid position. It will be realized from Fig. 8 that the case might arise in which at large inclinations, brought about, let us say, by improper flooding or a seaway, $\gamma\ v\ n\ n_1 < p\ k\ k_1$, therefore $B\ B\ \Phi = o$, or else the center of buoyancy shifting away from the side toward which the boat is inclined, thereby bringing into play a couple tending to increase the inclination. It will also be seen that here the limiting position, at which no more water can shift over, does not set in till later on, since the tanks are

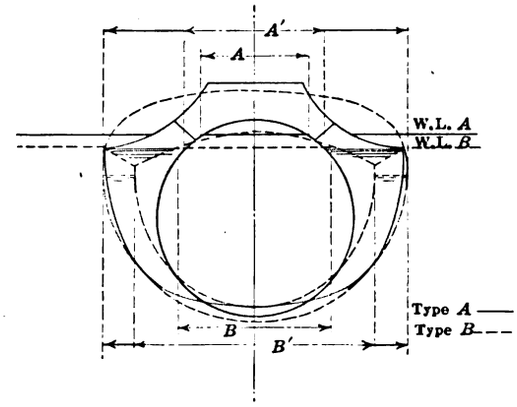

Fig. 9

considerably less filled than in the cases heretofore considered. Only after further flooding does the center of buoyancy rise and weight stability begin to act. In blowing or pumping out the tank, on the contrary, the moment $p\ k\ k_1$ becomes smaller, $B\ \Phi$ begins to travel toward the inclined side, and the boat again gets back its righting tendency. It is therefore advisable, also for these conditions of flooding, in which there is apparently sufficient stability of form for the upright position, to work out the curve of righting levers as indicated in Fig. 7.

Let us now consider the deductions which the designer may draw from these:

1. In the light condition the boat should already have, if possible, stability due to weight, *i. e.*, $B\ G$ positive.

2. The form of the ballast tanks must be such that the limiting position beyond which no more water can shift over sets in at small inclinations; furthermore, that the free surfaces of the ballast water are kept comparatively small, and that the tanks themselves have small leverages in regard to the axes through the center of gravity. The subdivision, longitudinally, to be so arranged that two adjacent tanks may remain empty while flooding and full while blowing the tanks (errors in the flooding maneuver or possible consequence of a collision which has affected the two compartments), without giving to the boat a larger inclination than is admissible in consideration of ease of handling.

Separating or partitioning off the port from the starboard tanks should really have no influence, since with kingstons and vents open they are in communication through the water and air outside. It is evident, however, that this communication would only then be complete if the rise and fall of the water level in the tanks could take place at the same rate as that with which the water outside rises and falls. Such, naturally, is not at all the case, the areas of the kingston and vent openings being too small to admit of this. It may even

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be assumed, to a certain extent, that for the short time normally required in flooding, the water in each side shifts over, so to say, "in itself," and that hence only the moments of inertia of the free surfaces about their own axes are effective. If, however, the operation of flooding is purposely prolonged, so that the boat remains for some time with tanks only partially filled, even the partitioning off of the tanks will not prevent a gradual equalizing of the water levels through the medium of the outer water and air. Nevertheless, such division will generally be accompanied by a considerable improvement in stability.

The requirement of proposition 1—positive $B\ G$ in the light condition—is probably always fulfilled in the "single-hull" boats, if only on account of their small stability of form. Due to their peculiar distribution of weight this requirement is also relatively easy of attainment, though it may require at least some fixed ballast. With "double-hull" boats, which in their distribution of weights somewhat resemble torpedo boats, in fact the more so the larger they become, the problem is more difficult. Outer hull and superstructure materially raise the center of gravity, to compensate for which a considerable amount of fixed ballast is required. In order to avoid too great an amount, the designer will naturally resort to the expedient of allowing a negative $B\ G$ in the light condition, at the same time giving to the ballast tank, as far as possible, such a form as will ensure the center of buoyancy passing above the center of gravity during the early stages of flooding. In Figs. 4 and 5 we have already seen the influence of the form of ballast tank on stability at inclinations. It would seem that the "double-hull" boat with cylindrical inner hull of circular cross section, type A in Fig. 9, is somewhat inferior in this respect to the Laurenti boat, type B. A mere glance at the illustration shows that the greater breadth of the upper part of the pressure hull decreases the free surfaces of the ballast tanks, and that the larger quantity of water lies in the lower part of the tank. If one compares the two types in conditions of flooding corresponding to approximately equal amounts of reserve buoyancy, one finds that type A has a smaller water plane—A as against B—and broader free surfaces in the tanks (not yet quite full), A' as against B'. Compared with the moment of inertia of the heavily drawn portion of the ballast water surface A' we have that of the surface B'. Evidently type B will in this condition of flooding be superior to type A as regards initial stability of form.

Change in breadth over outer hull in double-hull boats has little influence on stability during flooding, as the broadening of the water plane and the increase in the free surface go hand in hand. The breadth therefore should not be made greater than is necessary to give the boat the metacentric height found from experience to be desirable in the fully emerged or light condition. . . .

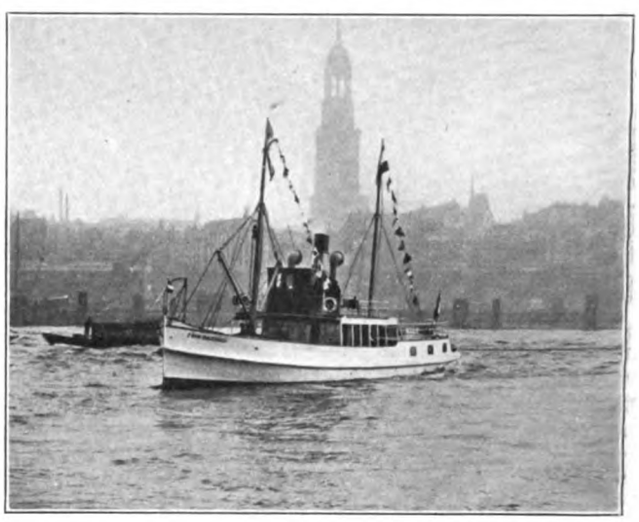
The requirement—small leverages of the tanks about the axes through the center of gravity of the boat—will be harder to comply with, both longitudinally and transversely, in the "double-hull" than in the "single-hull" boats. In the latter the tanks are inside, and extend from one-half to two-thirds the boats' length amidships. In the former they lie outside, hence farther removed from the center line plane, and usually reach as far as the ends of the ship, where they considerably affect the trim. By careful observations of trim during the operation of flooding in smooth water this action may, in a measure, be avoided; in a seaway, however, it will make itself very much felt. It is the business of the designer to so shape the ends that this action is as far as possible precluded.

Accidents to submarines which can be laid to want of stability have so far never come to knowledge, which goes to prove that all boats of the present day are, as a matter of fact, "non-capsizable" so long as the pressure hull is intact. But the larger the displacements and engine powers become the more will the relative position of the centers of buoyancy and displacement approach that of torpedo boats, and the less will it be possible, as mentioned above, to start out with the center of gravity lying below the center of buoyancy without unduly increasing the amount of fixed ballast. The shape and position of the ballast tanks therefore will require in increased measure the attention of the designer.

Passenger Motor Ship Fohr Dagebull

BY J. RENDELL WILSON

On the Continent of Europe there are numbers of Diesel-engined craft in service, the existence of which is not generally known in the ordinary course of events. It is rather difficult to realize this now, as the great interest taken in this type of motor ship has been the cause of the publication of details of nearly every vessel as soon as she is launched. Lately, however, I have unearthed a number of these boats, such as the M. S. *Kaiser, Kommandatur Helgoland* and the *Delphin,* and now I am enabled to give particulars of the *Fohr Dagebull,* a passenger motor ship that has been working between islands in the North Sea, Wyk, and the mainland for over a year with excellent results. Up to the time of writing



Passenger Motor Ship *Fohr Dagebull* in Service on the North Sea

no details have been published in the English language, so the following no doubt will be of interest:

The *Fohr Dagebull* is owned by the Wyk Steamship Company, of Wyk, who run a large fleet of steamers. In the past the company have endeavored to equip their vessels with modern machinery, and all the latest marine inventions are carefully watched, consequently they were among the first group of Western Europe owners to have a Diesel ship built. I understand that they have also experimented with gasolene (petrol) motors and low compression heavy oil engines and all classes of steam engines; but the Diesel has been found to be the most economical of all classes of propulsive machinery. In view of the difficult navigation of the waters in which the boat works considerable engine flexibility is necessary, so this unbiased report should be noted by other owners, particularly by those who are doubtful of adopting Diesel power.

She was placed in service in June, 1912, having been built at the yard of H. C. Stülken & Söhne, Steinwerder, Hamburg, to the German Lloyd class W. Her general dimensions are as follows:

Length	100 feet 9 inches
Breadth	19 feet 6 inches
Draft	4 feet 3 inches
Brake horsepower	120
Speed	10 knots

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It will be noticed that the draft is rather light; but this is necessary, as it is the maximum for the district she serves. Yet she has been found to be very stable and seaworthy. In addition to carrying passengers she transports general cargo and cattle. The forward mast is fitted with a derrick, and at aft there is a promenade deck for the passengers. Except for the absence of smoke there is nothing in her appearance to distinguish her from a steamer; but the actual difference will be realized when I say that she carries sufficient fuel in her tanks for twelve months' working of eight hours per diem at 10 knots. Fuel cost comparisons with a steamship of similar size on the same route are obtainable, and while *Fohrs Dagebull's* fuel only costs 0.018 MK. per effective horsepower-hour, the steamer's coal consumption costs 0.03 MK. per effective horsepower-hour.

The propulsive machinery of this motor ship consists of a six-cylinder (two maneuvering and four working cylinders) Benz-Hesselman Diesel engine of the direct-reversible, single-acting type, developing 160 indicated horsepower at 300 revolutions per minute. This type of motor is similar in design to the Polar-Diesel, and was constructed by Messrs. Benz & Company, of Mannheim, Germany, under license. The engine room is equipped with all the usual auxiliary plant for operating the winches and main engine, and there is a separate motor-driven electric lighting set.

Launch of the Battleship Oklahoma

The first of the United States battleships authorized in 1911 was launched at the yards of the New York Shipbuilding Company, Camden, N. J., March 23, and christened the *Oklahoma* by Miss Lorena Jane Cruce, daughter of the Governor of Oklahoma.

The vessel is 583 feet long overall, 575 feet long on the waterline, 95 feet 3 inches beam and 28 feet 6 inches mean draft, with a normal displacement of 27,500 tons, and a full load displacement of 28,400 tons. Propulsion is by twin screws driven by two four-cylinder triple-expansion engines, with cylinders 35, 55, 78 and 78 inches diameter and 48 inches stroke, supplied with steam from twelve Babcock & Wilcox watertube boilers. The total indicated horsepower is 24,800, designed to give the ship a speed of 20.5 knots.

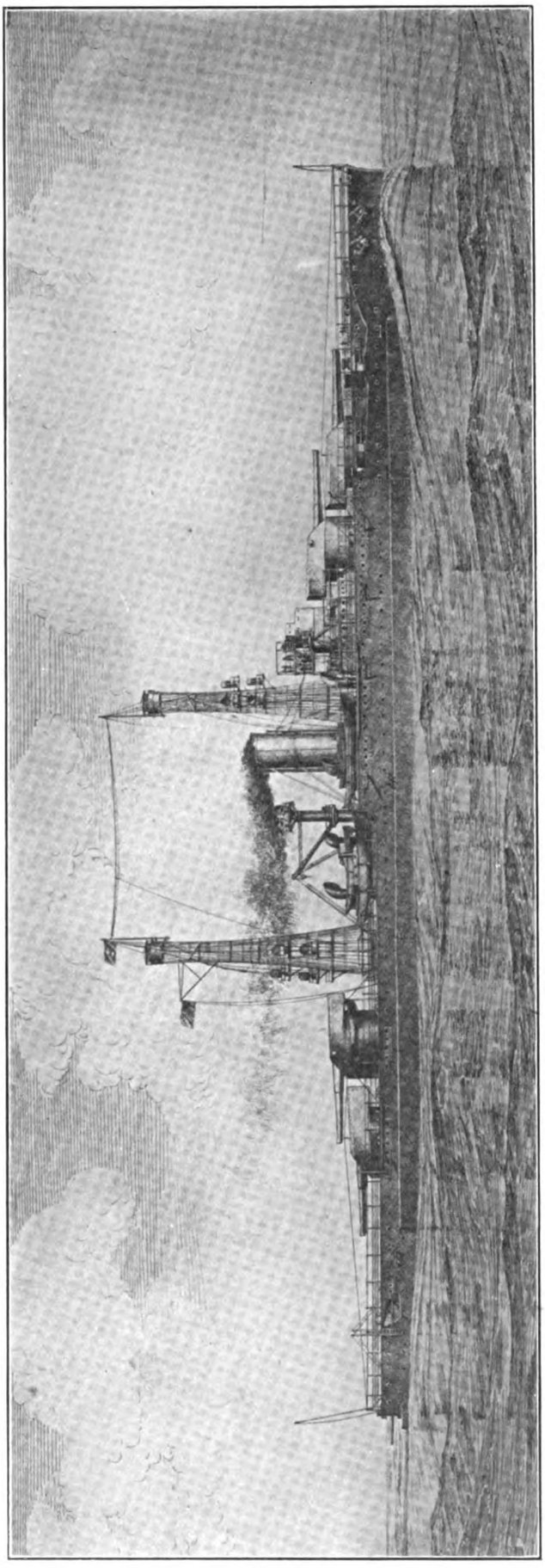
Oil fuel is used exclusively, and the ship's bunkers have a total capacity of 598,400 gallons. The total heating surface of the boilers is 48,000 square feet, and the weight of the machinery, 1,900 tons.

The main battery consists of ten 14-inch guns mounted in four turrets on the centerline of the ship. The forward and after turrets carry three guns each, while the other two turrets have only two guns each. They are, however, mounted at a higher level so that they can fire directly over the triple gun turrets. Thus the ship has a broadside fire of ten 14-inch guns and an ahead and astern fire of five 14-inch guns.

The secondary battery consists of twenty-one 5-inch guns, four 3-pounders, two 1-pounders and four submerged 21-inch torpedo tubes.

The main armor belt is 13½ inches thick amidships, and is 17½ feet wide, extending 8½ feet below the load waterline. The triple turrets are protected by 18-inch and 9-inch armor and the double turrets with 16-inch and 9-inch armor. The ends of the vessel are unarmored. The ship has a single funnel protected at the base with 13½-inch armor. The vulnerable parts of the ship are further protected with a 3-inch protective deck.

The *Oklahoma's* sister ship, which will be named the *Nevada*, is being built at the Fore River shipyard, Quincy, Mass. She will be fitted with Curtis turbines and Yarrow boilers; the two vessels will, therefore, furnish a further opportunity for the United States navy to investigate the merits of opposing types of propelling machinery.



United States Battleship *Oklahoma*, Launched by the New York Shipbuilding Company, Camden, N. J., March 23. (Drawing Made from Designs of the Vessel, Showing How She Will Appear When Completed)

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Severity of Winter Weather at Sea as Revealed by the Camera

Hardships and dangers at sea are never more formidable than in the winter months, especially on the North Atlantic, where gale follows gale and the prevalence of heavy storms taxes the skill and courage of the hardiest navigators and engineers to the utmost.

A striking illustration of the severity of a winter gale is given in the photograph on the opposite page, which shows the United States battleship *Vermont*, with all decks awash from stem to stern, fighting her way through a mid-winter storm. Seldom is the seaworthiness of a big steel warship better portrayed than in this case. With sailing ships, even when of large size, the result of a severe storm is likely to be the destruction of the vessel and the loss of her crew. In Fig. 4 can be seen the wreck of the Italian bark *Castagne*, which went ashore near Wellfleet on February 18. Four men were frozen to death in the rigging of this vessel, while eight survivors were brought to Boston.

Another unusual disaster occurred at Portland, Ore., on March 12, when a big water front fire caused the loss of over a million dollars' worth of property. Few of the vessels in the locality of the fire escaped without injury, and in Fig. 1 is shown the spectacular fire which destroyed the American steamer *Cricket*, which was loaded with asphalt. Fire swept the vessel from stem to stern, and she became a total loss.

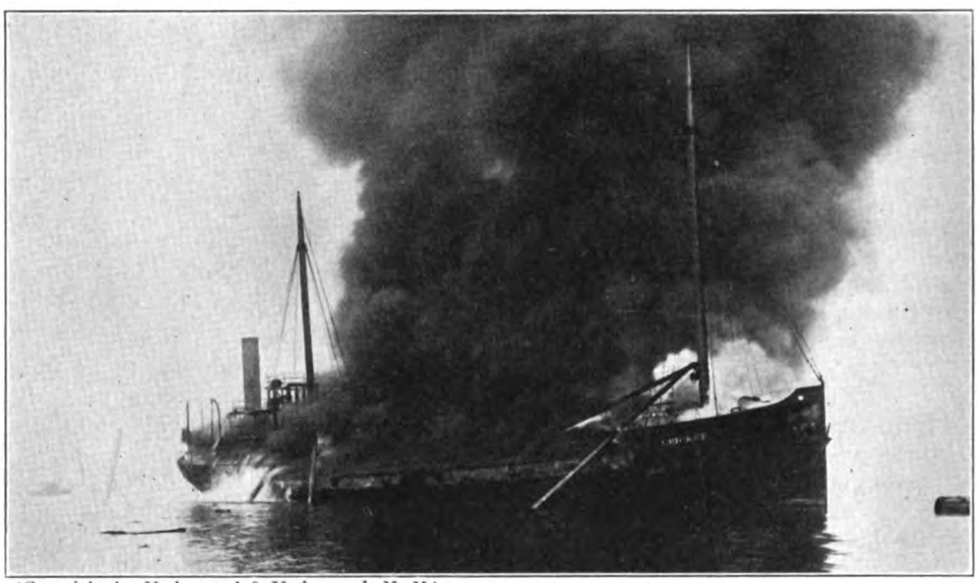

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Fig. 1.—American Asphalt Steamer *Cricket* Destroyed by Fire at Portland, Ore., March 12

Although less dangerous but scarcely less troublesome are the obstacles encountered in the winter months on account of ice.

Fig. 2 shows the mantle of ice that frequently covers the hull and rigging of incoming vessels after a stormy voyage, while Fig. 3 shows the ineffectiveness of a powerful ice-breaking steamer after an attempt to navigate an ice-bound river in Canada.

(Photographs by Underwood & Underwood, N. Y.)

Fig. 2.—Clyde Liner *Carib* Coated with Ice after Regular Voyage to Boston

Fig. 3.—Futile Attempt of Packet Steamer to Break a Channel Through the Ice in Bear River, N. B.

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Fig. 4.—Italian Bark *Castagne* Ashore near Wellfleet

Institute of Marine Engineers.—The twenty-fifth annual meeting of the Institute of Marine Engineers was held in London, February 26. The present membership of the Institute is 1,408, a net increase of 58 during the year. The obituary list included the names of two past-presidents, the late Sir William White, K. C. B., and the late Sir David Gill, K. C. B. The following officers and members of the Council were elected for the coming year: President, Sir Archibald Denny, Bart, LL. D.; Hon. Treasurer, Mr. Alexander H. Mather; Hon. Secretary, Mr. James Adamson; members of council, Messrs. A. E. Battle, P. T. Campbell, B. P. Fielden, H. A. Ruck-Keene and W. T. Seaton.

(Photograph by Underwood & Underwood, N. Y.)

Fig. 5.—U. S. Battleship *Vermont*, with Decks Awash, Fighting a Winter Gale on Homeward Voyage from the Mediterranean

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Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

An Old Story in New Words

This short account of the cause of an entirely preventable accident, which caused the death of one man, is simply an old story set to new words. It is written simply in the hope that it may call attention to the urgent necessity for casualty drills in the fireroom.

In order to give an intelligent idea of existing conditions, it will be necessary to describe briefly the fireroom installation.

The fireroom contained one watertube boiler, one auxiliary feed pump and one large blower. The boiler was fitted with two gage glasses, Scotch type, each having a self-closing ball valve at the lower end, so arranged that when the draincock was opened the lower connection would be automatically closed, thus allowing the glass to be blown through. After the drain cock was used it was always necessary to unseat this ball, by means of the lower gage glass cock, before normal communication between the boiler and the glass could be restored.

In order to safeguard the men on watch, in the case of blowing tubes, a large ashpit escape was led from the back of the ashpit to a self-opening hatch on deck. This spring hatch, practically airtight when closed, was released by means of a toggle hanging directly over the head of the water tender on watch. It is quite easy to see that, with an air pressure equal to four or five inches of water, all escaping steam, from an ordinary rupture, could be easily taken care of by simply opening the ashpit escape and speeding up the blower. The hatch furnishing access to the fireroom was almost directly over the head of the water tender on watch.

One night last fall, while the vessel was steaming at about 18 knots, the hand on the engine-room steam gage commenced waving rather wildly, thus furnishing a pretty good indication that something was wrong. A messenger was immediately sent to the fireroom to inquire about the condition of the water in the boiler. The water tender had hardly finished assuring him that everything was all right when three tubes blew out with great violence, instantly filling the fireroom with steam.

A moment later the deck hatch was opened from below and the water tender crawled out, surrounded by a cloud of steam. Those on deck immediately slammed the hatch shut, and, running forward, opened the ashpit escape. In a very few minutes the blower had so cleared the fireroom that it was possible to go below, haul fires and investigate.

The fireman was found in the fireroom, entirely uninjured, but the water tender was so badly scalded that he died shortly afterwards.

A careful investigation established the following facts: The water tender, having acquired the habit of using only one gage glass, was following out his usual practice. Seeing that the gage glass needed blowing, he blew it through, closed the drain cock and then forgot to unseat the automatic ball valve, thus leaving the lower connection to the boiler closed. His attention was probably distracted for a sufficient time so that when he looked again enough water had accumulated by condensation, etc., to show in the glass.

The water shown, however, was not in communication with the water in the boiler, so the indication shown was entirely false. The water had continued to get lower in the boiler until the gage in the engine-room began to show signs of trouble. The arrival of the messenger excited the suspicions of the water tender, so that he immediately tried the trycocks. Of course, he did not get water in the trycocks.

The water tender then made that old and ever-recurring mistake which has been the cause of so many fatal accidents. He took a chance—exactly the same chance that most water tenders will take under similar circumstances—and started the auxiliary feed pump full speed. He did not believe that the water was very low. He thought—just as we always think under similar conditions—that the water was just below the glass and that a few strokes of the pump would bring it in sight. But this time it didn't do as expected. The water was too low for recovery, so three tubes blew out, flooding the fireroom with steam.

In the excitment of the escaping steam, the water tender forgot the ashpit escape and attempted to make his own way out of the fireroom by means of the regular deck hatch. While he was getting out, the air pressure drove the steam out in clouds around him, burning him so badly that his case was hopeless.

The fireman did not leave the fireroom. He simply stood in front of the blower until the fireroom was well clear of steam.

The water tender in this case was a tried and competent man. He first got into trouble by neglecting small things, and, when the trouble arrived, things happened so quickly that he lost his head. Thus, he lost his life through an accident that was entirely preventable and which, having arrived, could have been handled with comparative safety by the apparatus installed.

It seems to me that this should further impress upon all engineers the great necessity for having casualty drills among the fireroom forces. It is very difficult to make men enter into such drills with spirit, since each believes that he will be fully able to meet any emergency that might arise. Ordinarily, men look upon such drills as entirely unnecessary, and, at best, they look upon them as necessary evils, to be endured simply because they cannot prevent them. However, regardless of this feeling, men should be so drilled that they will automatically do the right thing in case of the more common accidents.

When a man for whose training you are responsible is killed by some entirely preventable accident, you will wonder if you are not slightly responsible for his death. This will be especially the case if you have not carefully prepared him to meet the emergencies of his necessarily dangerous calling.

W. W. B.

Follower Bolt and Cylinder Cover

After the steamer *H*——— had proceeded about 8 miles from her dock a heavy pound was heard in the high-pressure cylinder on the top center. With the first report the upper engine room became filled with steam, and it began to rain cast iron and asbestos. The engines were stopped, and at a glance the false cover of the high-pressure cylinder was seen lying on the intermediate-pressure receiver, all of the asbestos having blown out of the cover. As the vessel was in a dangerous part of the channel it was necessary to start the engines and work the ship to an anchorage. This was done at reduced speed, and at every revolution the heavy pound could be heard, accompanied by a rush of steam into the engine room.

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On coming to anchor the cover was lifted, disclosing the fact that one follower bolt was missing. Upon examining the under side of the cover the bolt was found embedded in it, projecting the exact clearance. The cover was turned over and the bolt knocked out of the hole. It had broken at the bottom of the last thread, and was found to be of steel. The exact form of the bolt had been punched in the cover without fracture.

The hole was measured, and it was found that if it were made round a 2½-inch pipe tap would clean up a good thread. As there was a tap in the tool room and plenty of plugs on hand, the hole was chipped and filed round, tapped out, a well-leaded plug screwed home and the square cut off.

In the meantime the end of the old bolt was backed out of the piston and a new one inserted. The piston was measured on four points to determine if the rod had been sprung, which was found to be true. The cover was replaced and the engines started with 130 pounds of steam at reduced speed. As the repair proved tight the pressure was increased to the normal of 160 pounds and full speed resumed.

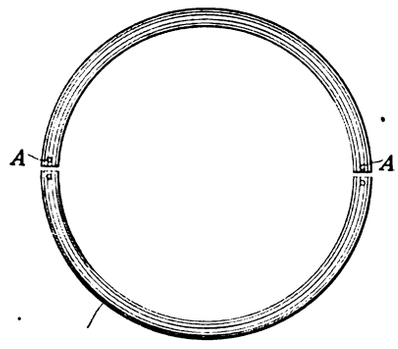
On arrival at the port of destination the plug was cut out and a solid cast iron plug, turned and threaded in the lathe, was screwed in with a ⅜-inch brass stopper pin tapped in one side. New follower bolts of Norway iron were also fitted. This engine with the repairs as described is still running on the coast. ENGINEER.

New York.

Wire Rings for Leaky Stuffing Boxes

Many engineers find it impossible to prevent steam and water from blowing by the piston rod and valve stems of an engine, due to the fact that the rods become worn and give too much clearance space around the rod in the bottom of the stuffing box, and also at the bore of the packing gland. The result is that the packing will work into the cylinder or by the packing gland.

To close up this clearance many engineers make, or have made, a ring of babbit or brass to fit the bottom of the stuffing box next to the packing gland. The writer has found that these rings take up too much space in the stuffing box, so that it is impossible to get a sufficient number of packing rings in the stuffing box to make a tight job; but if a ring made of No. 5 or 6 B & S gage copper wire is worked out to a good fit around the rod, this ring does not take up nearly as much space as a ring of babbit or brass.



Copper Wire Gage B and S 5 or 6 Size

Wire Ring Made in Two Parts

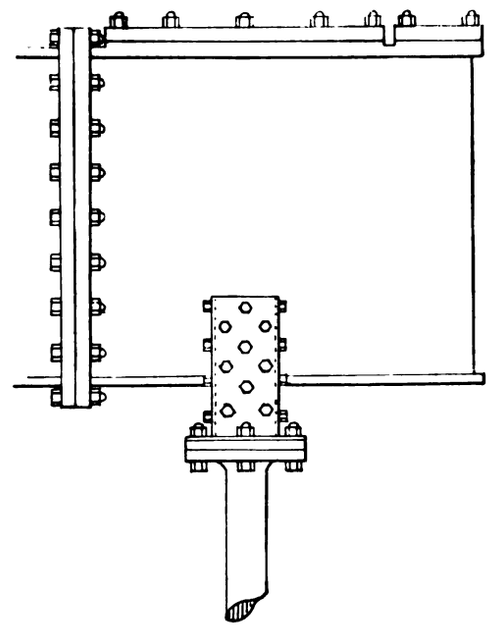
These rings are made in halves, as shown in the illustration. A small hole is drilled in each half of the ring, as shown at *A*, *A*. This is to keep the ring in place; while the packing is being placed in the stuffing box, the two halves of the ring are fastened together with small wires. After placing them around the rod, the wire ring is taken up by filing away at the two joints. The writer has had a set of these rings in use for the last two years and finds that they work satisfactorily in every respect.

There is another point about this arrangement which is important. When the rings are made in two parts they are kept in shape when placing them over the rod, whereas when the ring is made with only a single joint it has to be sprung over the rod and will not make a tight fit around the rod on account of its being pulled out of shape. H. A. JAHNKE.

Milwaukee, Wis.

Repairing a Cracked Cylinder

While a ship of the Red Star line was proceeding down the English Channel, bound from Antwerp to Philadelphia, both legs of the high-pressure cylinder were discovered to be cracked just above the flanges where bolted to the columns. A heavy I-beam crosses the steam chest about two feet above it, and a hydraulic jack was placed between the top of the chest and the underside of this beam. When the jack was set up the cylinder was securely held, but the chief engineer decided that it would be unwise to attempt to cross the Atlantic with a passenger list of between 700 and 800 depending on this temporary arrangement.



Position of Patches on Cracked Cylinder

After consultation with the captain it was decided to put into Falmouth. On arrival there the superintendent engineer at Antwerp was notified by telegraph, and on his arrival at Falmouth a gang of men from a local machine shop was secured to work under his direct supervision.

Lead templates, covering the legs of the cylinder and extending out over the flanges on same, were made, and from these templates patches were made of ¾-inch steel boiler plate. Holes for ¾-inch bolts, snug-fitted, were drilled in these patches after they had been carefully fitted in place, together with holes for the bolts that fastened the legs to the columns. Corresponding holes were drilled in the legs in front and on the sides for a ¾-inch tap, and when the patches were fastened in place, as shown in the sketch, the cylinder was as securely held as it was originally.

On arrival in Philadelphia the question of replacing the cylinder was discussed, but it was finally decided to let well enough alone and the cylinder was not replaced for several years, when a crack developed in the steam jacket. During this time not the slightest trouble was experienced with these patches. J. S.

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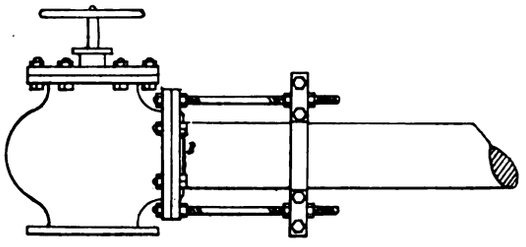
A Cracked Steam Pipe

While closing the main stop valves on the boilers in an ocean-going tugboat on arrival at the dock for orders, the main steam pipe was found cracked close to the flange, as shown at *B* in the sketch, the crack extending about one-third way around the pipe.

Orders were received to proceed immediately with a light tow to the home port, and the chief engineer decided that this could be done without very much delay. There were no facilities for repairing the damaged pipe in the place and it would mean a delay of several days to send the pipe away to have it repaired, this being the important factor that caused him to arrive at this decision.

Unlike an ocean liner, these tugboats do not carry a very large stock of repair material, and it required some ingenuity



Device for Strengthening a Cracked Steam Pipe

to obtain what was needed, but a marine engineer is seldom balked in an emergency.

The bands around the tops of a couple of ash buckets, made of ⅝-inch by 2-inch iron, were cut off and forged in the fireroom into a clamp, as shown at *A* in the sketch. While this was being done, a tube rod of ¾-inch round iron was secured and long studs made from it, as shown in sketch, the covering on the pipe meanwhile being removed.

When the clamp was made, the holes drilled in it and bolts procured, it was secured in place, as shown. Thimbles made out of pipe were placed between the halves of the clamp over the bolts, so that when the inner bolts were tightened the clamp compressed the pipe, thus obtaining a secure grip on it. Two opposite bolts were then removed from the flange and the long studs inserted in their places, and then the nuts on the other ends of the studs tightened until there was as much strain on the studs and clamp as could be safely borne.

When this was done, all was as shown in the sketch and the chief engineer felt confident that, even if the crack extended, which he did not believe it would do, the pipe would not tear away from the flange. His confidence in the job was not misplaced, as was evidenced by the fact that on arrival at the home port the crack had not extended at all, and he was complimented by the shore engineer for bringing the boat home with such little delay, two hours being the entire time consumed in getting the gear ready and putting it in place.

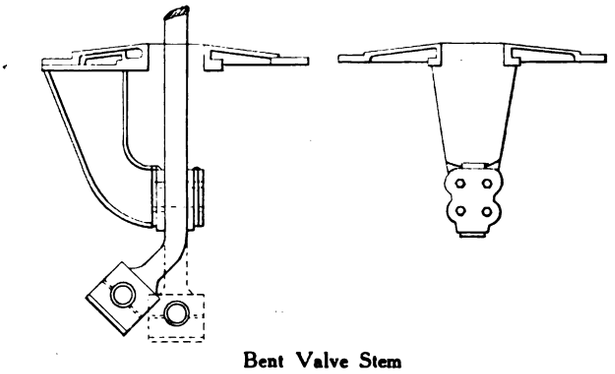
M. A. PENFIELD.

A Very Unusual Accident

A ship had made all the usual preparations for getting under way; her engines had been warmed up and everything in the engine room made ready to turn over the engines. The links were amidships, and the engineer moved the reversing lever in the go-ahead position. The reversing engine moved, but instead of the link blocks moving out in the radial link and the valves moving off the center position, uncovering the ports to admit steam into the cylinders, the high-pressure link block stuck fast in the link; and the reversing engine, continuing to move, bent the valve stem guide bracket and eccentric rods of the high-pressure engine. The ship went out of port with one engine in operation and work commenced on the disabled engine.

The high-pressure valve was examined and found to work freely and to be free of anything that would make it stick. So the accident was not caused by the valve being frozen, as the saying is.

One of the theories advanced to account for the trouble was that the pressure in the valve chest was not equalized and was so much greater on one side of the valve that it resisted the force exerted by the reversing engine to move the valve. While this was an ingenious theory and a probable one, nevertheless, to the writer's mind, the cause of the accident was due to the link block sticking and straining the valve stem out of line; and as the force continued, the valve stem guide and eccentric rods were badly bent.



Bent Valve Stem

It was impossible, with the facilities at hand, to straighten the valve stem bracket, which was of cast steel, so a line was run through the bracket and measurements made as to the extent of the bend. The brass bushing in the guide was bored out large and babbitted, after which the bearing was bored to fit the stem, with such regard for the altered alinement of the planed surfaces of the bracket as to bring the hole in line with the valve stem. The valve stem, which was three inches in diameter, was bent about forty-five degrees, close up to the yoke end. In straightening it some bumps were caused, which were removed by turning down the stem to two and seven-eighth inches for a distance of about twelve inches. To straighten the eccentric rods was quite a simple matter.

After assembling, the engine was tried; and everything being found satisfactory, it was used with the other engine, enabling the vessel to reach the next port with little loss of time. The valve stem was used for more than two years before being renewed.

J. E. C.

BE CERTAIN THAT STEAM IS ENTIRELY SHUT OFF BEFORE DISCONNECTING THE ENGINE.—A large steeple compound engine in a rolling mill was disconnected to make repairs to the crosshead brasses. Steam leaked by the throttle valve into the high-pressure cylinder. When sufficient pressure had accumulated to overcome the friction, the pistons moved, the expansive power of the steam increased the velocity and forced the pistons against the cylinder heads with such power that the high-pressure and low-pressure cylinder heads were broken and the engine wrecked. The intermediate-pressure engine of a vertical triple-expansion engine was disconnected, after being shut down, but before the steam was off the engine and the vacuum in the condenser destroyed, the piston was forced up the cylinder about half the stroke, then it fell back to the bottom of the cylinder, and though no damage resulted the workmen had a narrow escape from serious injury by the end of the connecting rod falling over on the frame of the engine when the piston rod rose.

C.

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Marine Articles in the Engineering Press

The New Shipbuilding and Engineering Works at Willington Quay.—The firm of Joseph T. Eltringham & Company, Ltd., shipbuilders, ship repairers and marine engineers, which was established at South Shields are far back as 1846, recently acquired an area of ground at Willington, Quay-on-Tyne, which many years ago was occupied for shipbuilding purposes by Palmers Shipbuilding & Iron Company, and thereon has erected one of the most completely-equipped shipyards for its size in England. The yard has a river frontage of 460 feet and is capable of dealing with vessels up to 325 feet in length. There are four shipbuilding berths, a fitting-out shop, joiner shop, blacksmith shop, engine shop, frame shed, power station and offices. At the west end of the yard space is reserved for the construction of a large graving dock. Early in its career, this firm acquired a world-wide reputation for the construction of tugs, trawlers and other small vessels. Of late years, however, they have made a specialty of high-class passenger steamers of moderate dimensions. The new yard was officially opened February 5. 4 illustrations. 1,100 words.—*The Shipbuilder,* March.

Japanese Institution of Naval Architects.—At the annual meeting of the Japanese Institution of Naval Architects, held November 14 to 17, the following papers were read: "On the Use of Special Steel in Warships," by Commander Y. Hiraga, Naval Constructor at Yokosuka; "On Some Experiments on Mild Steel and Special Steel Rivets," by Commander Hiraga and Lieutenant Hashiguchi; "On Recent Studies in Connection with Rivets, Riveting and Riveted Joints," by Lieutenant Y. Taji, Assistant Naval Constructor; "On Rolling and Anti-Rolling Tanks," by Dr. Suyehiro, Professor of Naval Architecture, Tokyo Imperial University; "On Watertube Boilers for Marine Purposes," by M. Miki, Engine Shop Manager of the Mitsu Bishi Works at Kobe; "On the Construction of Ships with Flanged Plates," by K. Ota, Surveyor to the Mercantile Marine Bureau, Department of Communications; "On the Preservation of Timber and On Bottom Painting," by Dr. T. Shiga; "On the National Flag and Its Use in Ships," by N. Matsunami; "On Vibrations of Ships and Instruments to Measure Them," also "On a Rollingless, Pitchingless and Waveless Ship," both by Dr. Y. Yokota, Professor of Naval Architecture, Tokyo Imperial University. A comprehensive account of the proceedings was contributed to this journal by Professor F. P. Purvis, of the Tokyo Imperial University, including abstracts of the President's address and of the most important papers. 9 illustrations. 4,500 words.—Engineering, *February* 6.

Three-Masted Schooner Aosta with Savoia Diesel Marine Engines.—The *Aosta* is a three-masted schooner 184 feet long, 28.2 feet beam and 14.3 feet depth, with a displacement of 1,050 tons and a deadweight capacity of 700 tons. There are three holds, each supplied by a steam winch, with the engineers' quarters and accommodation for four passengers in the poop deckhouse. The ship is fitted with a four-cylinder Diesel engine, manufactured by the Societa Anonima Cantieri Officine Savoia, Cornigliano, Liguire. The engine is of the two-stroke cycle type, with cylinders 13.75 inches diameter and 19.7 inches stroke, developing on 200 revolutions per minute about 440 brake horsepower, corresponding to the comparatively high mean effective pressure of about 127 pounds per square inch, assuming the engines to have a mechanical efficiency of about 73 percent. Besides the main oil engine, there is a donkey boiler for steam heating and for driving the auxiliary compressor and winches. The auxiliary compressor is driven by a steam engine of 25 horsepower. The four cylinders of the main engine are arranged in two sets of two each, with the scavenging pumps and compressors between the sets. The cranks of both the scavenging pumps and of the main engines are set at 90 degrees to each other, the advantage of this arrangement being the very good balance of rotating masses with a minimum degree of irregularity of running and the possibility of starting the main engine by allowing compressed air to act in the two double-acting scavenging pumps. The compressors are placed on top of the scavenging pumps. For actuating the valve gear, eccentrics and eccentric rods alone are used. Indicator diagrams taken from the engine when the ship was light, with the propeller only partly immersed, give a maximum pressure of 470 pounds per square inch, a mean effective pressure of 110 pounds per square inch, and an indicated horsepower of 520 for the four cylinders at 200 revolutions per minute. Assuming the mechanical efficiency of 73.2 percent attained at the shop trials, the brake horsepower works out at 380. 18 illustrations. 1,500 words.—*Engineering,* February 6.

The White Star Liner Britannic.—A very complete and fully illustrated description of the new White Star Liner *Britannic,* launched recently by Harland & Wolff, is given. The main particulars of the ship are: Length over all, about 900 feet; breadth, extreme, about 94 feet; depth, molded, 64 feet 3 inches; gross tonnage, about 50,000 tons; load draft, 34 feet 7 inches; displacement at load draft, over 53,000 tons; indicated horsepower for reciprocating engines for ahead and astern driving, 32,000; shaft, horsepower for low-pressure turbine for ahead drive, 18,000; service speed, 21 knots; number of decks, 9; passenger accommodations, first class, 790; second class, 836; third class, 953; total passengers, 2,579; crew, 950; total, 3,539. The article is divided into sections dealing with the construction of the hull, arranagement of the decks, electric installation, ventilation, sanitation, the general arrangement of the propelling machinery, the reciprocating engines, the exhaust turbine, maneuvering gear, condenser and boiler feed plant, boilers, pumping arrangements, refrigerating plant, applianaces for handling and working the ship, life boats and lowering gear, and the launch of the vessel. The boiler plant, which includes twenty-four double-ended and five single-ended boilers, is arranged in six boiler rooms. The boilers are all 15 feet 9 inches mean diameter, the double-ended boilers being 21 feet mean length and the single-ended boilers 11 feet 9 inches mean length. The heating surface of each double-ended boiler is 5,702 square feet and the grate area 130.8 square feet, while in the single-ended boilers the heating surface of each is 2,822 square feet and the grate area 65.4 square feet. The main reciprocating engines, which are of the four-cylinder, triple-expansion type,, with cylinders 54, 84, 97 and 97 inches diameter and 75 inches stroke, are located in one engine room with the usual feed, sanitary and bilge pumps and all auxiliaries associated with the boiler feed, the refrigerating machinery, and, on the lower deck level, a fully-equipped workshop. The exhaust turbine driving the center shaft is in a separate compartment, abaft the reciprocating engine room, exhausting into two condensers. The turbine is about 50 feet long and weighs complete 490 tons. It operates at full power at 170 revolutions per minute. The wing screws, driven by the reciprocating engines, are 23 feet 9 inches diameter, designed to run at 77 revolutions per minute, while the center propeller, which is four-bladed, is 16 feet 6 inches diameter. 81 illustrations. 15,000 words.—*Engineering,* February 27.

Marine Refrigeration and Insulation.—Although great diversity of opinion exists among ship owners as to the most suitable system of refrigeration, nevertheless the author of

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this article maintains that for marine work the compression system is highly advantageous. Three principal types of the compression system are now in general use—the air, the ammonia, and carbon-anhydride systems. These three systems are described briefly, after which the subject of insulation is taken up in more detail. It is pointed out that no mater how efficient the refrigerating machinery may be the ultimate economy of the plant greatly depends upon the quality and nature of the medium used for insulation. By practical tests and long experience, as well as theory, it has been found that those substances possessed of minute air cells offer the highest resistance to the passage of heat energy and are the most perfect insulators. In the opinion of the writer, the best results are obtainable from a combination of wood and granulated cork; cork, being impervious to heat, capable of withstanding moisture, very light (one cubic foot weighs about 7 to 8 pounds packed) and easily handled. Another insulating material which has been adopted in steamers built in the United States is the waterproof lith board made by the Union Fiber Company, of Winona, Minn., from a combination of flax fibers and mineral wool. It is claimed that this substance has been proved by reliable tests to be 7.25 percent more efficient than cork board, but the writer has had no experience with lith board. Discussing further the subject of insulation, the thickness of insulating material and the methods of application of the insulating material, are taken up in detail. An important point is brought out, namely, that since it is impossible to examine continually the steel work behind the insulation, it is of the utmost importance that all steel work should be riveted perfectly tight and watertightness insured before the insulation work is commenced. Much damage may be caused to a valuable cargo by leaky rivets and bolts in watertight decks, etc. After giving some brief notes regarding the refrigerating machinery on the Cunard Liner *Mauretania,* and on the White Star Liners *Olympic* and *Ceramic,* a very thorough description is given of a typical modern refrigerated steamer, the vessel chosen being *El Uruguayo,* one of five fine twin screw steamers recently completed for the fortnightly express service between the river Plate and London, and owned by the British & Argentine Steam Navigation Company and Messrs. Houlder Brothers & Company. These vessels were built to the plans and specifications of Messrs. William Esplen Son & Swainston, Liverpool, and each has a total insulated capacity of about 400,000 cubic feet, ranking among the largest meat carriers yet constructed. The vessels are 440 feet long between perpendiculars; 58 feet 8 inches beam, molded; 38 feet depth, molded to shelter deck; 8,360 gross tons; 4,693 net tons; with a deadweight capacity on a 27-foot 6-inch draft of 8,300 tons. On a load draft the vessel has a displacement of about 15,000 tons, and provision is made for 12 first class passengers and 350 emigrants. Four decks extend over the full length of the ship, and seven steel transverse bulkheads extend to the shelter deck, besides which there are three bunker screen bulkheads. All five holds as well as the 'tween decks are completely insulated for the cargo of chilled and frozen meat, granulated cork being employed throughout the cargo holds, except for the machinery bulkheads, where silicate cotton is used for insulation. The refrigerating machinery is of the standard duplex marine type, supplied by Messrs. J. & E. Hall. The vessel is propelled by two sets of triple expansion engines at a service speed of 15 knots, steam being supplied by 6 single-ended boilers working under Howden's forced draft system. 23 illustrations. 4,000 words.—*The Shipbuilder,* March.

The New Harbor Works and Dockyard at Gibraltar.—By Adam Scott. This paper gives a general description of the comprehensive project which has been carried out for the inclosure and defense of the harbor and the extension of the dockyard at Gibraltar. This scheme included an extension of the south mole by 2,700 feet, the construction of a detached breakwater 2,720 feet in length, a large northern mole with coaling jetties, the extension of the naval yard, including the construction of three large graving docks, wharf walls, slipways, pump house, workshops, storehouses, officers' rooms, etc., and the deepening of the harbor.—A paper read before the *Institution of Civil Engineers,* February.

Corrosion of Iron and Steel Structures and Their Preservation.—By F. Crosby-Jones. The object of this paper is to seek out the best means of abating the inroads of corrosion on iron and steel. The author concludes that all structures should be composed of the same metal as far as other constructions will allow; surfaces should be even and free from depressions, cracks and curves, wherein water can lodge; pockets that allow of the collection of water should be avoided; all members should have free air circulation around them; provision should be made where necessary for the drainage of water; joints, rivet heads, bolts and nuts should be given special attention to insure exclusion of water and all parts that are not easily visible should have careful inspection. When painting has to be done, it is advisable that each coat should be of a different shade, in order to facilitate inspection and to check the number of coats used. Above all, before a protective coating is applied, the metal must be cleaned and dried, then a good material used and the work must be properly carried out. 6,250 words.—Paper read before the *Institute of Marine Engineers,* January.

Some Experiments on the Condensation of Steam.—By Gordon C. Webster. This paper describes a series of experiments made by the author during his tenure of a post-graduate research scholarship in the Mechanical Engineering Department of the Royal Technical College, Glasgow, to determine the rate of condensation of steam upon a metal surface, with special reference to the influence of the velocity and density of the steam. The data obtained from these experiments are presented in the form of tables and curves, from which the following points are brought out: For a given temperature difference between steam and the metal the condensation rate varies with the speed of the steam. For steam at constant pressure and velocity, the condensation varies as the difference in temperature between the steam and the metal. The effect of the steam pressure and velocity, however, cannot be neglected. The curves readily show the effect of velocity upon condensation, and also the effect of density upon condensation, both of which, contrary to conclusions arrived at by the previous investigators, must be taken into account. 12 illustrations. 6,000 words.—*Transactions of the Institution of Engineers and Shipbuilders of Scotland,* December.

Observations on Ocean Temperatures in the Vicinity of Icebergs and in Other Parts of the Ocean.—By C. W. Waidner, H. C. Dickinson and J. J. Crowe. The records of sea water temperatures obtained by means of an electrical resistance thermometer and a Leeds and Northrup temperature recorder installed on the U. S. S. *Chester* and *Birmingham* in their patrol of the North Atlantic ocean in June and July, 1912, show that the temperature variations in parts of the ocean far removed from ice are often as great and sudden as in the neighborhood of icebergs. So far as the records obtained are concerned, the authors conclude that it does not seem possible to draw positive conclusions as to the absence or proximity of ice from the temperature records of seawater. On the other hand, the temperature record may give valuable information on the approach to shore or shallow water, on the identification of characteristic ocean currents, and even of the proximity of icebergs in some parts of the ocean where the variations are less erratic than in the regions in which the authors' observations were made. Further investigations are desirable before final conclusions are drawn. 16 illustrations. 5,200 words.—*United States Naval Institute Proceedings,* December.

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New Books for the Marine Engineer's Library

The Diesel Myth. By F. Lueders. Size, 6½ by 10 inches. Pages, 236. Illustrations, 12. Berlin W., 1913: M. Krayn. Price, $1.15, paper covered.

The author makes a startling attack upon Dr. Rudolf Diesel, the originator of the modern high-pressure oil engines. He attempts to prove from Diesel's writings that the modern so-called Diesel engine was not invented, but was evolved more by accident during the unsuccessful attempts of producing the rational heat motor of the original patents. The author tries to show that the fundamental assumptions and theories of Diesel were incorrect or impracticable, and that for this reason an uncooled cylinder with a perfect Carnot cycle could never succeed, to say nothing of the fact that the cylinder and engine dimensions would have been prohibitively large to secure the necessary air surplus. Dr. Diesel is considered guilty of a shifting opportunism, which hid failures and readily advanced new facts that promised glory and reputation. The book freely acknowledges the inestimable value of the so-called Diesel engine, but considers Dr. Diesel as the purely accidental cause of its production.

It is almost to be regretted that so much careful labor in the arrangement of documentary material should have been directed to a negative purpose.

A Year With a Whaler. By Walter Noble Burns. Size, 5½ by 8¼ inches. New York, 1913: Outing Publishing Company. Price, $2.00.

Mr. Burns has written an unusually readable book. It gives a phase of life on board a whaler that is seldom written up. As Mr. Burns shipped as a green hand, he naturally writes from the point of view of whaling as seen by the men in the forecastle. It is a true picture of life on a whale ship, quite different from a story published some years ago by Mr. Bullins, entitled, "The Voyage of the Cachelot." Mr. Bullins' story did not sound true; and as the writer of this review was in the Arctic Ocean years ago, he knows that it was not true and that Mr. Bullins' picture was overdrawn to produce picturesque effects. On the other hand, Mr. Burns presents his side of the story in a straightforward manner, and his book is a valuable contribution to literature regarding this industry, which is gradually becoming extinct. He makes considerable of the desire of sailors to run away, apparently not appreciating that it is an inborn trait of all sailors to want to run away as a matter of habit. He does not appreciate the difficulties under which the men in the cabin labor with an irresponsible crew, for all sailors are irresponsible. At the same time he is to be congratulated upon writing such a good story.

Computations for Marine Engines. By Professor C. H. Peabody. Size, 6 by 9 inches. Pages, 206. Illustrations, 51. New York, 1913: John Wiley & Sons, Inc. Price, $2.50 net. London, W. C., 1913: Chapman & Hall, Ld. 10/6 net.

For many years instruction in marine engine design at the Massachusetts Institute of Technology, under Professor Peabody, was carried out with the aid of loose leaf notes which the students invariably had bound in such form as suited their needs for future reference. The appearance of this book will, therefore, be gladly welcomed not only by the students at the Institute, but also by other men engaged in marine engine work. As the book is arranged to meet specifically the special needs of the method of instruction adopted at the Institute, where complete designs of actual marine engines are available for comparison and study by the students, and where the student's work in marine engine design is controlled by giving him the data and proportions he is incapable at first of selecting for himself, no attempt has been made to present in the book more than the methods of computing the proper size and strength of the parts of a marine engine similar to those in good practice. To other students and engineers who do not have detailed drawings and data from actual designs at hand, it might be pointed out that such material is continually appearing in the engineering press and can be easily obtained. The chapters in the book are as follows: Preliminary Computations, Indicator Diagrams, Forces and Rotative Effects, Computation of Strength, Balancing Engines and Internal Combustion Engines.

The Engineering Index Annual for 1913. Size, 6½ by 9¼ inches. Pages, 510. New York, 1914: The Engineering Magazine Company. Price, $2.00.

The publishers of The Engineering Index Annual are to be congratulated upon their promptness in issuing the volume for 1913. The book was on the market within six weeks of the close of the calendar year, a service that will be greatly appreciated by the users of such an index. As has been the case in previous years, the book comprises a complete index of all articles published in the engineering press during the year, so classified and cross-indexed that a few moment's search will inform the specialist of the number, length and nature of all articles that have been published during the year on any engineering subject. Furthermore, the publishers of the index are in a position to supply at short notice and at a minimum cost copies of any of the articles indexed, if not out of print. The value of this book is obvious, and a copy of it should be in the library of every engineer.

"Verbal" Notes and Sketches for Marine Engineers. Eighth Edition. By J. W. M. Sothern. Size, 6 by 9 inches. Pages, 676. Illustrations, 545. Glasgow, 1913: James Monro & Company, Ltd. Price, 12s. net.

In order to bring this well-known manual of marine engineering practice thoroughly up to date, the author has added a new appendix covering the subjects of internal combustion engines, Diesel engines, steam turbines and boilers. A number of new drawings, notes and calculations referring chiefly to Diesel oil engines, boilers and marine turbines, have been introduced, the latter including exhaust turbines and geared-down turbines. It may be recalled that when the seventh edition of this book appeared in 1911 the book was practically rewritten and re-illustrated. The book is intended for the use of naval and mercantile marine engineers of all grades, students, foremen, engineers, etc., and is specially compiled for the use of engineers preparing for examinations of competency at home and abroad. The book contains a vast amount of practical information, the value of which is greatly enhanced by the use of carefully-prepared sketches and drawings, many of which are reproduced to a large scale in the form of plates. Every marine engineer should have a copy of this book and make free use of it.

Great Lakes Register. Size, 12 by 8¼ inches. Pages, over 600. Cleveland, Ohio, 1914: Great Lakes Register.

The rules and tables for the construction and classification of steel, iron and wooden vessels navigating the Great Lakes now have the approval and endorsement of Bureau Veritas, of France. The existing alliance of Bureau Veritas with Great Lakes Register enables the committee to issue certificates of classification for over-sea navigation to Lake-built vessels, and the value of the Great Lakes Register Rules and Tables in connection with the shipbuilding and commerce of the Great Lakes is thereby greatly enhanced. The greater part of the Register is composed of classified lists of the steam vessels and sailing vessels on the Great Lakes. The hull and machinery data for the vessels are tabulated in convenient form, and a system of symbols and abbreviations is used to indicate the construction features.

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ENGINEERING SPECIALTIES

New Type ½-Inch Electric Breast Drill

The Stow Manufacturing Company, Binghamton, N. Y., has on the market a new type of electric breast drill with a capacity for ½-inch holes in iron or steel and ¾-inch holes in hard wood with Jennings bit. The drill is furnished in two types, one for alternating current of 100 or 220 volts,

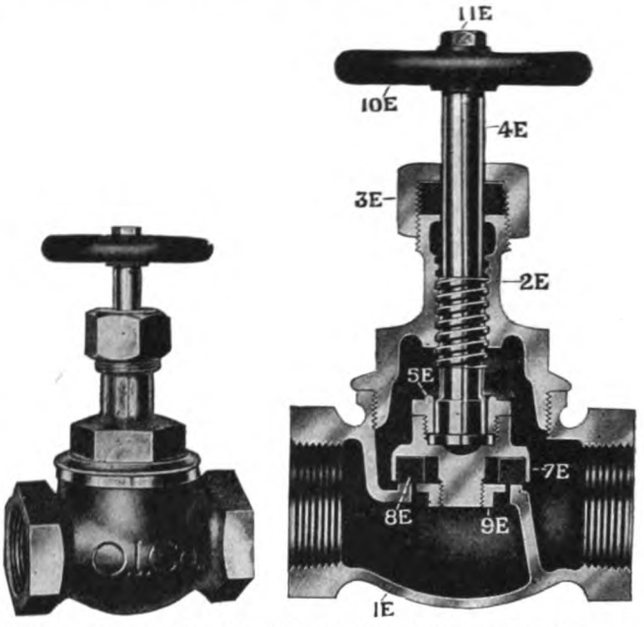
60 cycles, and the other for direct current of 120 or 220 volts. The first machine is 5¾ inches diameter, 13 inches high without the chuck and weighs 22 pounds. The other machine is of the same diameter, but has a height of 13½ inches without the chuck and weighs only 20 pounds. The manufacturers claim that these weights are as light as it is practicable to use with this size of drill. All parts of the drill are equally balanced, making it an easy tool to handle. The reduction gears are so designed that power is transmitted equally from the opposite points on each gear.

Brooke Motor Exhibit at Olympia

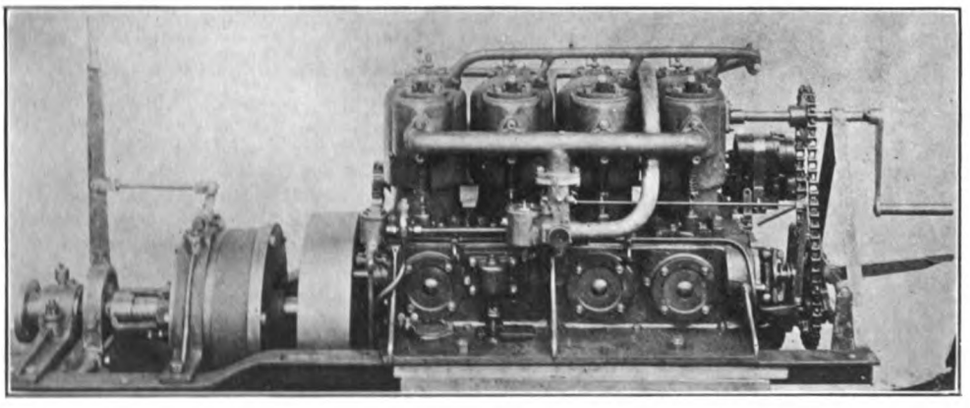
Since previous marine motor exhibitions were held many alterations have been made in the details of construction of the motors manufactured by J. W. Brooke & Company, Ltd., Adrian Works, Lowestoft. These alterations, however, relate chiefly to the accessory gear. At the Olympia-Aero and Motor Boat Exhibition, held in March, this firm exhibited sixteen of its motors, ranging in size from 3 to 120 horsepower. In addition there was a 33-foot Brooke racing hydroplane engined with a 270-horsepower, 8-cylinder, V-type Brooke motor capable of a mean speed of 41.8 knots, and also a 20-foot launch equipped with a 4-horsepower, single-cylinder, Brooke motor. Another feature of the exhibit was a 15-horsepower, single-cylinder, two-stroke, Brooke semi-Diesel motor. The actual power developed by this motor is 21 at 480 revolutions per minute. It is designed essentially for using the crude oils having a specific gravity of about .86. The fuel consumption is guaranteed not to exceed .55-pound per horsepower per hour. The semi-Diesel motor is non-reversible, but is equipped with a reversing gear of the epicyclic type. A very important feature with all the Brooke motors above 18 horsepower is the fact that the injection pipes are now jacketed and the lubricating oil is passed through these jackets, which thus perform the double operation of warming the incoming gases and keeping the lubricating oil cool. Brooke-Zenith carburetors are fitted to all Brooke motors except the 3 and 4-horsepower types.

The "O. I. Co." Composition Disk Valve

The composition disk valve manufactured by the Ohio Injector Company, Wadsworth, Ohio, is made of a high grade of steam metal, all parts being made to gage in order to insure



perfect fits in pipe threads and interchangeability of parts. The composition disk is made of a special compound especially adapted for use under severe service of all kinds. It is claimed that the composition disk will not break, crack or become brittle and pit. The disk wears down to a thin ring, thus giving an exceptionally long service, with the advantage over re-grinding or metal disk valves that it costs much less to renew a disk than it does to regrind a valve. The valves are designed for working pressures up to 200 pounds per square inch and have been approved by the United States



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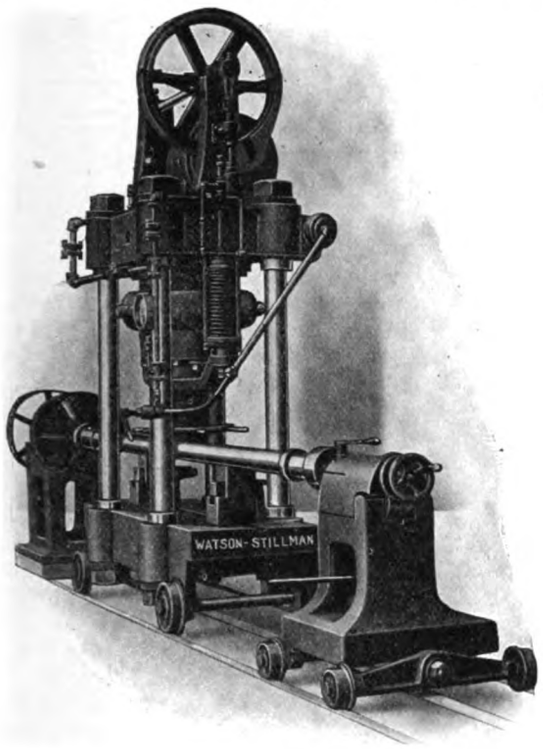
Steamboat Inspection Service. The packing for the spindles consists of a special molded split ring which fits the stuffing box and spindle accurately and requires very little compression to make a steam-tight joint. This ring is composed of braided asbestos thoroughly lubricated and coated with graphite to prevent friction and wear on the stems. The areas in the valves are far in excess of the pipe areas.

Hydraulic Shaft Straightener

The Watson-Stillman Co., New York, has recently produced an hydraulic press that has a capacity of 325 tons, which is sufficient for taking the bends out of any steel shaft up to 10 inches diameter, the length being limited only by the extent of the foundation provided.

As shown in the illustration, it is a motor-driven, self-contained unit, requiring no outside air or hydraulic system. There are three independent parts: the head stock, which is



stationary, and the press and tail stock, which are on rollers to permit their adjustment to varying lengths of shafts. The bed rails are flush with the floor, so that when not in use the movable parts can be rolled to one side, leaving the floor clear of obstructions. The head and tail stock are similar to those of a lathe, except that the centers are hinged to follow the movement of the shaft ends when the bend is made.

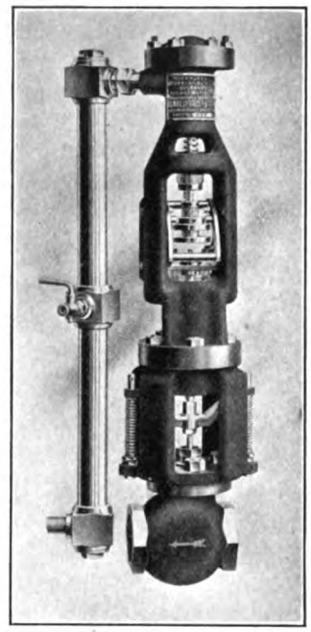
The shaft is revolved from the head stock and the "high point" marked. The press is then moved to that point and the bending blocks adjusted. The ram has a maximum movement of two inches and screwed concentrically into it is a square-threaded adjustment screw, which compensates for the different diameters of the shafts, and also enables the operator to predetermine the flexure desired. This, it is claimed, positively eliminates all danger of overbending.

The entire hydraulic power plant, including a 5-horsepower motor, pump, reservoir, etc., is mounted on the top platen of the press. The floor space required is 3 feet 6 inches wide by the length of the shaft, plus 6 feet. The total net weight of the press is 19,300 pounds.

"Thermofeed" Differential Pump Governor

The "Thermofeed" differential governor, which is manufactured by Ronald, Trist & Company, Ltd., 4 Lloyds avenue, London, E. C., is a device which shuts off the supply of steam to any class of steam or power-driven pump whenever the pressure becomes excessive, the excess sufficient to stop the pump being anything from 3 pounds per square inch upwards. The device aso admits a supply of steam to the pump by opening a double-beat throttle valve when any predetermined lower pressure is attained. A closed cylinder fitted with a piston which is fitted with a rod extension receives the main water pressure from the feed line on its upper side, while on its lower side is fitted a spiral steel spring. In this way the pressure on the feed line is converted into mechanical movement which is utilized to operate the control mechanism.

A downward movement of the main piston and its rod with its movable head pieces depresses a spindle to which is fitted the "thermofeed" double valve. This permits steam entering into a small cylinder, which, in turn, by means of a piston



directly over the rod or spindle and the double-beat throttle valve, closes the latter. One of the circular plates or head pieces on the upper or power cylinder will, on a drop in the pressure of the feed line and on its upward journey, engage with a pair of projections attached to a curved trigger piece. This trigger piece, having previously held the control valve in its down position until the upward pull on the projections permits it to trip, causes the small cylinder to exhaust to the atmosphere and thus readmits steam to the pump.

The control spindle, to which the control valve is attached, has a central poppet piece working in conjunction with a spring. The object of this is to prevent injury to the valve mechanism from any violent blow which might be given by the upper piston through erratic movement of the pump, such a blow being taken by two projections cast on the frame.

The Fulton (Diesel Type) Oil Engine

The Fulton-Diesel oil engines are of the high-speed, heavy-duty, single-acting, four-cycle type with fully-inclosed crank case, constructed to use crude oils, residues or ordinary kerosene (paraffin) for fuel. Three sizes are on the market for marine use, a 3-cylinder 50-horsepower engine, a 4-cylinder 70-horsepower engine, and a 6-cylinder 100-horsepower engine. The cylinders are all close ground cast iron, cast separately with large spaces for cooling water. The cylinder heads are

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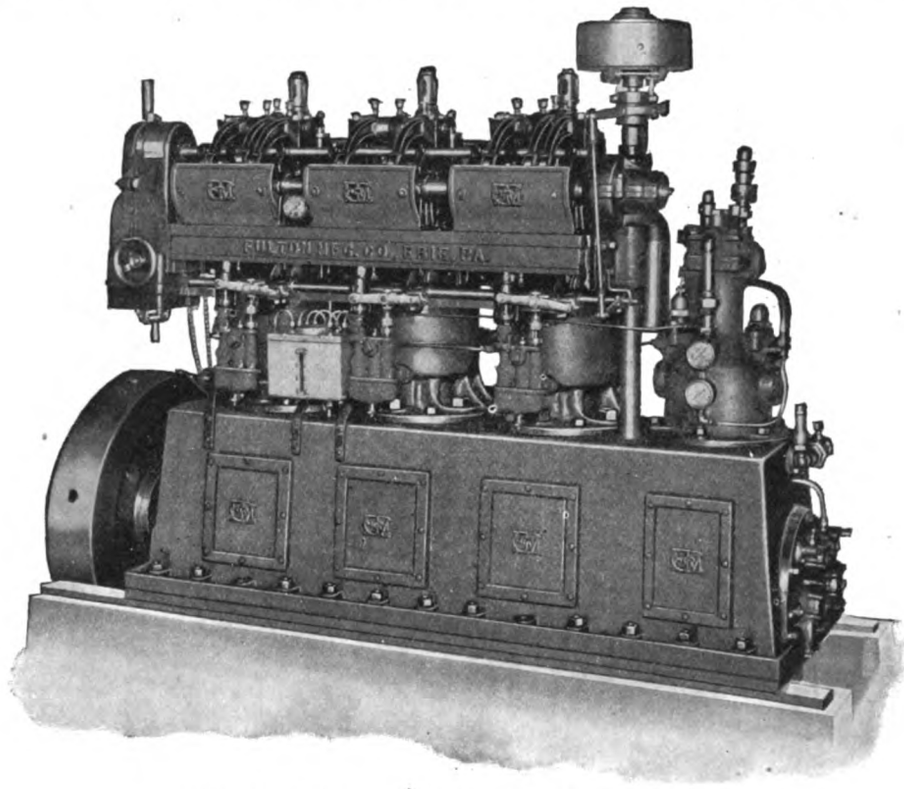
of a special grade of cast iron carefully designed with a view to overcoming undue strains. The pistons are of cast iron of the trunk type, fitted with hammered cast iron rings carefully fitted into grooves. Six rings are assembled above the wrist pin to insure uniform compression and two scraper rings are at the bottom to prevent an excessive amount of lubricating oil from reaching the compression chamber. The crank case is of the fully inclosed type bolted to the engine bed on the center line of the crank shaft. Rods of special high-grade hammered steel tie the cylinders directly to the engine bed, thus removing from the crank case the severe stresses incident to high compression.

The cylinder heads are fitted with air-starting, fuel-injection, suction and exhaust valves. The body of the fuel injection valve is made of bronze in two parts, so constructed that it can be removed without dismantling any of the levers. The needle valve is of nickel steel, ground to size and seated in the lower half of the valve body. This valve is closed by a heavy compression spring and forced open by a lever actuated by a cam mounted on the cam shaft. Burning plates that may be renewed are attached to the lower end of the injector and are held in place by a cone-shaped nut securely locked. The suction and exhaust valves are interchangeable, made of Tungsten steel. They are guided at the top to prevent side wear of the stems and are mounted in cages which are easily removed. The air-starting valves are of nickel steel, also guided above the spring to prevent side wear or bending.

The valves are actuated by a cam shaft of large diameter, driven by spiral gears and provided with Hess-Bright radial and thrust ball-bearings running in a bath of oil. The vertical shaft actuating the cam shaft is of the same material as the cam shaft and is driven by spiral gears from the crank shaft. The vertical shaft is also provided with Hess-Bright radial and thrust bearings submerged in oil. The cam levers are of cast steel with hardened tool steel rollers and pins with screw adjustment for clearance at the tappet end, bronze-bushed for rocker shaft bearings.

The entire system of four pumps for cooling water, lubrication, fuel supply and bilge, which are located on the front of the crank case in a group, may be operated by hand with a single handle without disconnection or danger to the operator. The pumps are interchangeable, so that one can be substituted for another without delay.

The compressed air is furnished by a two-stage compressor with superimposed pistons driven directly from the main crank shaft. After being compressed to approximately 105 to 120 pounds per square inch in the first stage, the air is delivered to an intercooler and then to the high-pressure stage, where it is compressed to about 825 to 975 pounds per square inch, after which it is delivered to a second cooler and then stored in a small air receiver for fuel injection. As the compressor is designed to deliver more air than is required for fuel injection, the surplus is stored in two large receivers at a pressure of from 700 to 1,000 pounds per square inch for starting. The pressure in the injection air varies with the load; that is, from 800 pounds for half load to 975 pounds for full load, or 1,000 pounds for 10 percent overload.



3-Cylinder, 50-Horsepower Fulton (Diesel Type) Oil Engine

Forced lubrication is supplied to all the crank shaft bearings and wrist pins. The crank shaft is drilled through its entire length and a small self-priming rotary pump circulates the oil from the engine bed to all bearings located inside the crank case and up through the hollow connecting rods to the wrist pins. A greater quantity of oil than is actually needed for lubrication is supplied, thus cooling the bearings without waste, as the oil flows back to the crank chamber, where it is filtered and used over agin. An overflow valve in the system regulates the amount of pressure, which is normally held at 15 pounds. The entire oiling arrangement is automatic in starting and stopping with the engine.

The speed of the engine is controlled by a governor of the centrifugal type, with exposed adjustment mounted on the vertical shaft and supplied with a hand control to increase or decrease the engine speed at the will of the operator by regulating the amount of oil delivered by the fuel pumps.

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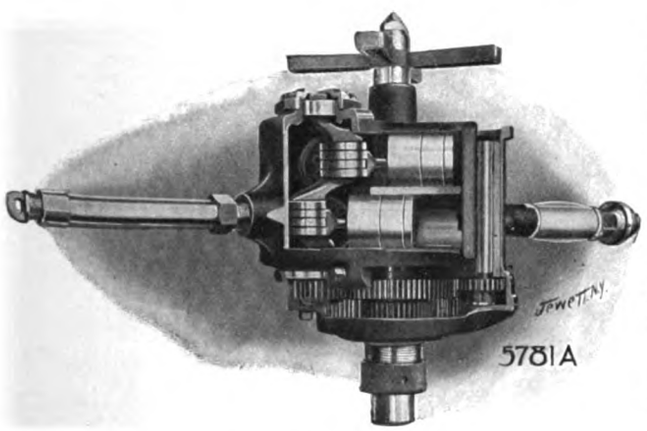
A handle and hand wheel supplemented by interlocking push buttons enables the operator to control every movement of the engine. The handle has three positions, namely, "barring," "air start" and "running." The push buttons serve to connect or by-pass the fuel for any cylinder when the handle is in the position for running. These buttons are so interlocked with the handle that starting air and fuel cannot be supplied to a given cylinder at the same time. The hand wheel serves to put more or less load on the governor, thereby controlling the speed of the engine.

The Fulton Diesel engine is manufactured by the Fulton Manufacturing Company, of Erie, Pa., who make a guarantee of a fuel consumption of .55 pound of oil per horsepower hour. In a recent test, however, the results of which are given below, the actual consumption of a 50-horsepower engine was only .5 pound of oil per hour.

	Cost per Hour.	Cost per 100 Hours.
50 h. p. 4-cycle gasoline (petrol) engine, 6 gals. gasoline (petrol) at 16 cents (0/8) per gal.	$0.96 (4/0)	$96.00 (20/0/0)
50 h. p. 4-cycle kerosene (paraffin) engine, 7 gals. kerosene (paraffin) at 8 cents (0/4) per gal.	.56 (2/4)	56.00 (11/13/4)
50 h. p. steam engine, 200 lbs. of coal at $5.00 (1/0/10) per ton	.50 (2/1)	50.00 (10/8/4)
50 h. p. semi-Diesel oil engine, 4¼ gals. of oil, at 4½ cents (0/2¼) per gal.	.19 (1/8)	19.12½ (3/19/8)
50 h. p. Diesel engine, 3½ gals. of oil at 4½ cents (0/2¼) per gal.	.15 (3/4)	15.75 (3/5/7½)

Improved "Little David" Drill

A noteworthy advance in the pneumatic tool line is the improved "Little David" drill which was brought out a short time ago by the Ingersoll-Rand Company, of New York and London. This is the only drill on the market having connecting rods running on roller bearings combined with crankshafts running on roller-bearings. In addition, the new tool has all the advantages of the previous type, such as unusual accessibility to all parts, absence of hinged joints on the connecting rods, and cylinder heads cast integral with the drill casing. The fewness of parts and general simplicity of the tool are striking features.



The shell is so designed that the entire motor apparatus may be assembled or disassembled through the crank case by the removal of the cover. The motor, or engine, is of the angular, four-cylinder, single-acting, reciprocating piston type, each pair of pistons being attached to opposite throws of a double crankshaft, and each acting in balance. All four connecting rods are exactly alike and are interchangeable. Each consists of but a single part, made by drop-forging a piece of selected steel.

The connecting rods run on Hyatt roller bearings, which it is claimed greatly reduce friction and give an easier running tool. The connecting rods are attached to the pistons by ingenious spring arrangements, whereby ease of assembling is secured. The piston ends of the rods are ball-shaped, over which flat steel springs are slipped. These balls have their bearings in the center of the pistons, forming ball and socket joints, permitting the connecting rods to yield to pressure from any direction without causing the pistons to bind in the cylinder. This construction also permits the pistons to turn in the cylinders, so that wear is evenly distributed.

The crankshaft works in F. & S. silent-type ball bearings. These bearings are of the separator type, which it is claimed is superior to the full type of bearings for machines of this character operating at medium and high speeds, as, in the full type of construction, the balls come in contact and wear flat rings in their circumferences in very short time, resulting in loose bearings and generally unsatisfactory operation. The rapid wear is largely due to the fact that the balls are rotating in opposite directions at their points of contact, and the wearing effect is therefore doubled. The spindle is provided with a ball thrust bearing interposed between the shell and feed spindle, in such manner that the main frame is relieved of all thrust or strain.

Each valve controls two pistons which act on alternate strokes. As the valves are completely balanced, and of the rotating type instead of reciprocating, wear is equalized. The valves are geared to the crankshaft through the medium of a spindle gear. The valves are steel, hardened and ground, operating in bronze-bushed chests, giving a combination of two of the best wearing surfaces. The setting of the valves is very simple, as it is merely necessary to see that the letters stamped on the valve and crankshaft pinions register with letters on the main gear.

These tools may be made reversible or non-reversible at the will of the operator. This is accomplished by changing the position of the sliding sleeve on the throttle handle. With the exception of the light wood-boring type, all sizes are provided with compound gearing, insuring great power at all speeds.

The "Little David" drill is made in five sizes. No. 1 is for heavy drilling, reaming, tapping and flue rolling; No. 2 is for similar work of a lighter nature; No. 3 is for light drilling and reaming. The No. 12 size is fitted with a chuck for a 4-inch wood-boring auger, and the No. 13 size has a chuck for a 2-inch wood-boring auger.

Personal

A. L. HOPKINS has been elected president and Homer L. Ferguson, vice-president, of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., of INTERNATIONAL MARINE ENGINEERING, published monthly at New York, N. Y., required by the Act of August 24, 1912.

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ALDRICH PUBLISHING CO.,
H. L. ALDRICH, President and Treasurer.

Sworn to and subscribed before me this 12th day of March, 1914.

OSCAR M. PICKRUHL.
(My commission expires March, 1915.)

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SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

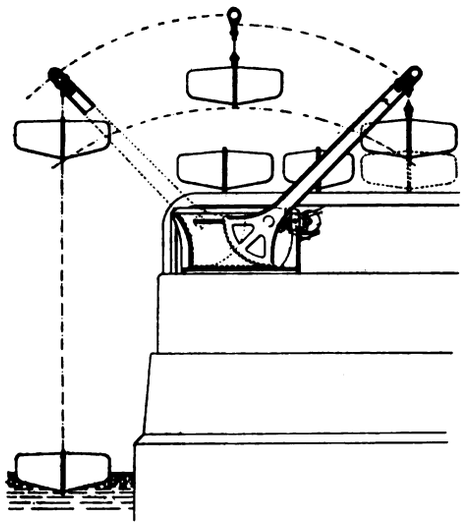
American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millertown, N. Y.

1,083,597. NAVIGATOR'S SPEED INDICATOR SHIP'S LOGS. HENRY H. CUMMINGS, OF NEWTON HIGHLANDS, MASS.

Claim 1.—In an apparatus indicating means to indicate the theoretical travel of the ship through the water, means to vary at will the action of said indicating means, and operating mechanism, including separate counters, one for each engine, for operating said indicating means in response to the mean revolutions of said ship's engines, said counters indicating at the same time the actual separate revolutions of the respective engines. Eighteen claims.

1,086,309. CRANES OR DAVITS. GUSTAF RENNERFELT AND ANDREAS P. LUNDIN, OF NEW YORK, N. Y., ASSIGNORS, BY MESNE ASSIGNMENTS, TO ASTOR TRUST COMPANY, TRUSTEE, A CORPORATION OF NEW YORK.

Claim 1.—The combination of a davit, a track to support it, a nut mounted pivotally in the davit, a frame joined with the track, a casing mounted on trunnions in the frame, a worm-shaft projecting with



both ends through the casing and threaded into the nut, and end-thrust bearing and a radial bearing for the worm, both said bearings being contained within the casing, and means for rotating the worm. Fifteen claims.

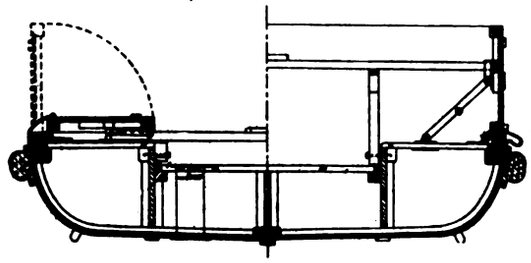
1,083,448. FITTING SUBMARINE SIGNALING APPARATUS IN VESSELS. SIMON LAKE, OF MILFORD, CONN., ASSIGNOR TO LAKE TORPEDO BOAT COMPANY, OF BRIDGEPORT, CONN., A CORPORATION OF MAINE.

Claim 1.—In combination with a submarine or submersible torpedo boat having an air-tight compartment in the hull thereof, a housing fixed to the hull of the boat in said compartment and surrounding an opening in the hull and opening to the exterior of the boat, and a sound producing apparatus supported by the housing with its resonant body extending into said housing and fixedly supported beyond the outer lines of the hull, said apparatus forming a closure for the inner end of the housing within said air-tight compartment. Six claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

10,432/1913. COLLAPSIBLE OR PARTIALLY COLLAPSIBLE BOATS. H. McLEAN, of 1 WATER ROW, GOVAN, GLASGOW.

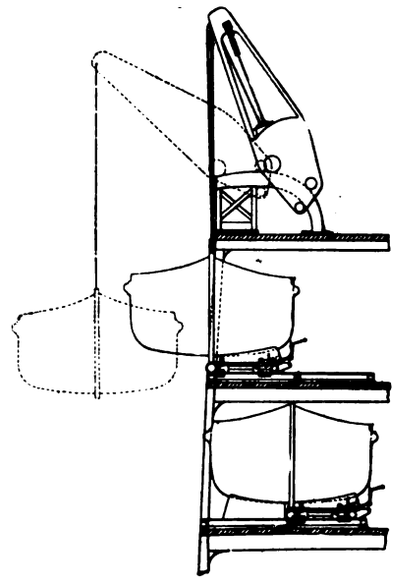
Claim.—Under this invention an improved collapsible boat consists of a lower structure or hull, sub-divided into compartments and decked over



its entire length, a portion of the deck being relatively lowered so as to constitute a sunk well provided with relieving tubes for draining water and discharging it into the sea; a collapsible upper structure follows the deck line to the extremities of the boat, the sides of which structure are made of rigid material and hinged inboard along the straight of the boat side, whilst its fore-and-aft ends are made of flexible material suitably supported and hingeably secured to the deck.

1,193/1913. STORING AND HANDLING SHIP'S BOATS. THE MARTIN PATENT DAVIT CO., LTD., AND A. J. LEWOWICZ OF 9 UNION COURT, LIVERPOOL.

Claim.—According to this invention there is provided on one or more decks, below the deck, on which is mounted a pair of davits, athwartship rails, on which a carriage carrying a lifeboat can move in such a way that in its normal position the boat shall be well inboard of the



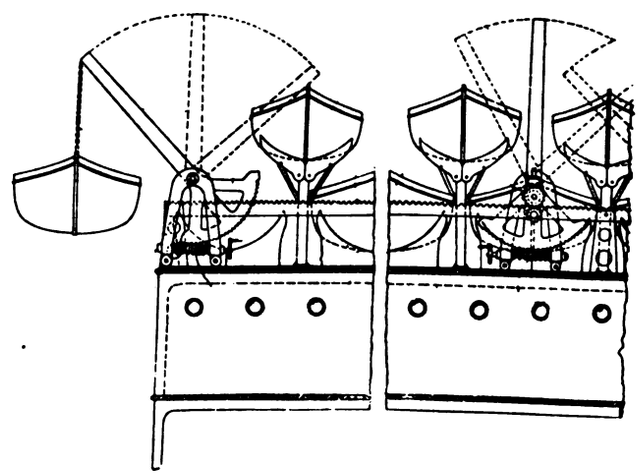
ship's side, but that when the boat is required for use it may be propelled outboard so that it can be lowered by the davits on the top deck. The rails are formed in sections which are hinged so that they may be folded back out of the way. In this manner one pair of davits on the top deck may serve not only a boat or boats on its own deck but also a boat or boats on one or more lower decks.

1,194/1913. APPARATUS FOR LOWERING SHIPS' BOATS. THE MARTIN PATENT DAVIT CO., LTD., AND A. J. LEWKOWICZ, OF 9 UNION COURT, LIVERPOOL.

Claim.—According to this invention, in order that the boat shall be lowered on an even keel, each fall is led back to a separate drum, the two drums being arranged co-axially side by side, but while one is fast with the brake and hoisting machinery, the other is not fast and a clutch is provided by means of which the loose drum can be uncoupled from the fast drum and locked in a fixed position so that the fast drum can be rotated in one direction or the other independently of the other drum to adjust the level of the boat. The clutch is preferably so formed that the loose drum is locked before it is disconnected from the fast drum.

23,448/1912. IMPROVEMENTS IN OR RELATING TO THE STOWAGE AND LAUNCHING OF SHIPS' BOATS, RAFTS AND THE LIKE. D. MACDONALD, DEPUTY MARINE SUPERINTENDENT, BRITISH INDIA STEAM NAVIGATION COMPANY, LTD., AT BOMBAY.

A davit of the type which can swing freely about a center in a vertical plane toward and from the water is trunnioned in a block which can be moved along athwartship guides by means of screw shafts, into



a position adjacent to any boat in a group placed inboard of one another, and put into an upstanding or sloping position, as may be desired, the swinging of the davits being performed by toothed quadrant on the lower end of the davit, controlled by a worm journaled in a bracket fixed to the block.

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